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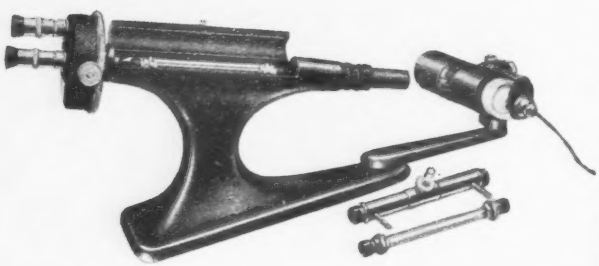

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COPYRIGHT AND SCIENTIFIC DEVELOPMENT

QUESTIONS of copyright were raised at the Royal Society Scientific Conference held in 1948, and in consequence the Council of the Royal Society issued in the following year a Declaration of Fair Copying, to which in the course of a few months more than seventy other societies and publishers in Great Britain had subscribed. The Copyright Bill*, which was read for the first time in the House of Lords on October 26 and after a lengthy examination in committee and on report received its third reading on March 22, is thus of special interest to the scientist and technologist. The Bill illustrates the complications which may arise out of the impact of technological advance and block attempts to adjust the law to the new conditions created. As the Lord Chancellor, Lord Kilmuir, explained in moving the second reading of the Bill on November 15, 1955, it is a comprehensive measure which, when enacted, will contain all the law of Britain on copyright matters. It will replace the Act of 1911, in which the British law of copyright was first codified, and three minor measures which were left unrepealed at that time; but it leaves unrepealed those sections of that Act (15 and 34) which relate to the receipt by certain libraries of free copies of books published in the United Kingdom. Those provisions are not matters of copyright and, as the Lord Chancellor said, are best dealt with otherwise than in a copyright statute.

The present Bill is designed to give effect to the report of the Copyright Committee, of which Lord Reading and Sir Henry Gregory were successively chairmen, issued in October 1952. In accordance with that report, the rights of an author, dramatist, composer or artist in his work are dealt with in one part of the Bill, while those rights given to other forms of copyright, such as sound recordings, broadcasting programmes and the like, are dealt with separately in Part II. So far as possible, the Bill also deals with the rights given to different kinds of works and the acts which constitute infringement in different sections; thus artistic works, for example, are dealt with in a different section from literary, dramatic and musical works—a procedure which, while promoting clarity, also makes the Bill longer and in itself extended the proceedings in the House of Commons.

Apart from restating the law of copyright in a different form, the Bill makes considerable changes in the present law. These, in the main, fall into two categories. First are those which will enable Britain to ratify two international conventions for the protection of copyright. In particular, by omitting the qualifications in the 1911 Act that during the past twenty-five years of the copyright life of a published work that work can be re-published as of right by any person who pays to the copyright owner the statutory royalty of 10 per cent, and the power of the Judicial Committee of the Privy Council at any time after the death of the author of a work which is being published or performed in public to over-ride any refusal of the copyright owner to permit re-publication, it will enable Britain to adhere to the revised convention of the Berne Copyright Union. The Copyright Committee in its report urged that the advantages of continued adherence to the Berne Union were overwhelming and greatly outweighed any disadvantages attending the repeal of these provisions. In particular, as was noted by Lord Conesford as well as the Lord Chancellor, the United States, which has hitherto abstained, has now signed and ratified the Universal Copyright Convention, and this came into force on September 16, 1955. Ratification of the Convention will therefore offer great advantage to British authors and publishers and to British export trade in books.

The second group of changes arises from the scientific advances which have been made in the fields of photo-copying, recording and broadcasting. It is here that the major difficulties arise, and the division of opinion which was manifested in the discussions in Parliament on the Bill was not entirely reconciled. Lord Kilmuir dealt first with the changes that have been required by the improvements in photo-copying, for example, microfilming. These provisions relating to the copying and publication of copyright works in libraries and archives are set forth in clause 7. Such methods have been of great advantage to students, but have placed libraries in jeopardy of actions for infringement. Lord Kilmuir said with justice that it would be helpful if statutory authority were given to libraries to provide methods for copying and also to deal with unpublished manuscripts, of which the ownership of the copyright might be unknown. He claimed that the clause was designed to help the student who needed photo-copies for his own use, with the minimum of disturbance to the rights of the copyright owner, and that it also facilitated publication of ancient unpublished manuscripts in public archives where the copyright owner could not be traced.

The clause provides that the copyright in an article contained in a periodical publication is not infringed by making or supplying a copy of the article, if the copy is supplied by a library of a class prescribed by the Board of Trade by regulations made under the clause. The regulations apply solely to libraries not established or conducted for profit, and copies may only be supplied to persons who satisfy the librarian that they are required solely for private study or research, that not more than one copy of the same article is supplied to any one person, nor more than one article in any one publication is copied, and that the costs of production, including a contribution to the general expenses of the library, are met by the persons to whom the copies are supplied.

This clause thus gives force of law, by and large, to the Royal Society's fair copying declaration, but only so far as periodical literature is concerned.

* Copyright Bill (H.L.). (As amended on Report.) Pp. 78. (London: H.M. Stationery Office, 1956.) 2s. 6d. net.

Copying from books is dealt with in separate subsections which cover the librarian of such non-profit libraries if he is unable by reasonable inquiry to identify the owner of the copyright in the book it is proposed to copy. It may be doubted, however, whether the Bill distinguishes any more clearly than the report the essential character of the scientist's need for copying. The Lord Chancellor, in moving the second reading in the House of Lords, spoke of the requirement to help those who contribute to the advance of the spiritual side of man, and at the report stage in particular Lord Mancroft, the Joint Parliamentary Under-Secretary of State for the Home Department, was most emphatic as to the need to respect the point of view of the author. Lord Mancroft, however, while alive to the importance of safeguarding the rights of students and of the libraries, was inclined to regard the rights and needs of the author of scientific and technical papers or books entirely in commercial terms, and his opposition to some of the amendments suggested by Lord Chorley was in consequence somewhat over-stated.

As Mr. Leslie Wilson pointed out, in commenting on the Copyright Committee's report (see *Nature*, 170, 1108; 1952), for the scientist, and often for the technologist also, publication is seldom a matter of commercial reward. The financial return, if any, is usually nominal, and the real profit is in the increase of his professional reputation. His interest runs very largely with that of science or technology itself in demanding as wide and free a circulation of his results as possible, and the real problem is that of securing for him and for the community the maximum advantage which inventions like microfilming offer in the way of scientific and technical communication, consistent with fair dealing to those who in the first instance took the responsibility and financial onus of publication. The element of cost has to be considered, but rather in relation to that of publication than in terms of the return to the scientist or technologist.

The question of fair copying requires consideration, in fact, in relation to the problem of scientific communication in general, and to those investigations which have recently been initiated by the Nuffield Foundation. As has already been emphasized, the rights and needs of the scientist or technologist who has written the book or article are closely related to those of the scientific or technical community of which he is a member. Indeed, it could be argued that without the facilities which Lord Chorley stressed, it would be difficult for the scientist or technologist to complete his paper or book, and there is more in the point that Lord Chorley made about the scientist and technologist having the maximum access to the materials he needs than Lord Mancroft was disposed to concede. In these days when costs of publications are mounting out of all proportion to the resources of most libraries, it can easily happen that only an industrial library can afford to subscribe to and file some particular periodical, or in a particular area purchase a very expensive monograph. Unless that library is legally entitled to provide a copy of a particular paper or passage, the scientist or the technologist may be put to an expensive and tedious journey to a distant part of the country, or be unable to consult the reference he needs.

Lord Mancroft rightly emphasized that, although industrial organizations often place their libraries freely at the disposal of scholars, access to them remains a matter of grace and favour. That must remain: they can never be on all fours with the libraries of public institutions and universities or public libraries; but the development of an adequate regional library system in which industrial libraries often already co-operate might well provide a way out of the difficulty. Lord Chorley's attempt to extend the clause to cover such libraries was defeated; but, as Lord Douglas of Barloch pointed out, Lord Mancroft did not really dispose of the argument or appreciate the place which the specialized libraries of industry have now come to occupy in the library resources of Britain.

A second point which occasioned some argument and difference of opinion in the House of Lords relates to the copyright of an article in a periodical. Under clause 4 of the Bill, as Lord Lucas pointed out at the second reading, if the article is commissioned, the copyright rests not in the author, as at present, but in the person who commissions the article. This clause was amended in committee to provide that the work should not be used for a different purpose or published otherwise except by express agreement between the author and the person commissioning the work. The amended clause, however, was challenged on the report stage by Lord Douglas as well as by Lord Chorley and Lord Faringdon, and their objections were not entirely removed by the assurances of the Lord Chancellor and Lord Mancroft.

What seems clear is that some far more fundamental thinking is needed about the impact of modern developments in photo-copying, for example, a scientific or technical communication, than is apparent in the drafting of this Bill. More is involved than questions of copyright and author's rights in fair copying, and it is unlikely that all difficulties will be removed by improvements in the law of copyright. It might have been expected, however, that the Government would be more aware of the practical needs and of the importance of such problems for technological and scientific advance. As it is, the Government appears to be as averse to facing the real issues in regard to the needs of the scientist or technologist as it has been in asserting the public interest against the restrictive practices of the Musicians Union, although the Bill as amended in the report stage deals more realistically with television and sound broadcasts.

Some concern was also expressed, both in committee and at the report stage, as to the effect of the Bill on the use of broadcasting and television in education. In the report stage on February 21, the Lord Chancellor moved the insertion of a new clause after clause 36 covering the use of copyright material for education, which he claimed represented a reasonable balance between the needs of schools and the

rights of authors and composers. Quoting from Lord Jowitt's speech on December 1, he agreed that authors and composers have given us much that makes life worth living, and that we should be most careful not to erode their rights more than is necessary. As regards the performance of copyright works and copyright material, the Lord Chancellor said that it is necessary to limit the exception to schools; and although the amendment, as Lord Bridgman admitted, goes a long way to meet the points raised by the local education authorities, Lord Chorley and Lord Silkin expressed disappointment that university and adult education were not also included. Lord Chorley, however, had not sufficiently completed his inquiries to be satisfied that the point was of such importance in university teaching to put down a formal amendment, but there may well be some scope for further inquiry along the lines that have already been pursued at Bristol.

The complexity of the whole subject is indicated by the mere fact that in the nine days the Bill was before the House of Lords nearly three hundred and fifty amendments were considered and some thirty of these were down for the third reading. Some of these last went far to remove misgivings expressed throughout the earlier discussions. In particular, an addition to clause 7 places inter-library copying, so far as periodicals are concerned, on all fours with copying for students, and commercial libraries are not debarred from participating in such arrangements. Lord Mancroft, indeed, anticipated that such libraries would join in the general scheme, and that articles in out-of-print scientific periodicals would figure largely in the easier copying thus made possible. The controversial clause regarding television and sound broadcasts was also clarified during the third reading and was accepted by Lord Silkin as meeting the main objection of the critics.

In his concluding speech for the Government, Lord Mancroft was able to claim with justice that the clause affecting libraries, as now amended, gives librarians the powers that the Library Association told the Copyright Committee they needed. Any widening of these provisions, he held, could only be at the expense of the copyright owner. Lord Mancroft also claimed that the clause in no way hampers librarians in exercising any rights they may now have as a result of arrangements with publishers, such as the Royal Society's fair copying declaration, or with copyright owners. The clause simply gives librarians rights which they do not possess under the existing law, and the safeguards it provides for the copyright owner operate only when these new rights are being exercised.

The Bill is not a political party measure, and the debates in the House of Lords have considerably clarified many technical issues. Some, like the syndication of articles, as Lord Silkin noted, merit further discussion and could appropriately be discussed by professional bodies of scientists and technologists before the Bill is further considered in the House of Commons. What is clear, however, is that there is still much room for clear thinking and careful inquiry and experiment as to the place of such media as broadcasting and television in the communication of ideas and in research as well as in education, quite apart from the possibilities which photo-copying itself offers for the improvement of scientific and technological communications. The Copyright Bill is both a reminder that the law of Britain needs adjustment to the new conditions which scientific advance has brought, and a challenge to creative thinking about the possibilities and implications of new powers and processes and the way they can best serve mankind.

PLANT AND ANIMAL TISSUE CULTURE

Cultivation of Animal and Plant Cells

By Philip R. White. Pp. xi+239. (London: Thames and Hudson, Ltd., 1955.) 35*s*. net.

DR. P. R. WHITE is one of the originators of plant tissue culture. In 1934 he announced the realization of unlimited cultures of isolated roots, and then in 1939 that of tumorous tissues. Since then he has been pursuing his research on the culture of animal tissues without having abandoned the plant domain. The originality of his work is well displayed in the volume under review.

This work is a technical manual which rises above a general level when comparing methods of culturing animal tissues with those for plants. The title does not correspond exactly with the contents, for the book deals not only with the culture of true cells (at least, animal cells) but also with tissues (cambial tissue, parenchyma), with organs (embryonic organs of animals, isolated roots) and even with plant embryos. The manual thus examines all types of cultures *in vitro*, with the exception of those concerned with adult animal organs, by methods derived from that by Carrel-Lindbergh.

White recalls first of all the philosophical origins of the culture method *in vitro*, and then summarizes briefly the subsequent history. This résumé, although schematic, is nevertheless lively. The succeeding chapters deal with techniques: how the same laboratory can be adapted for culturing plant, as well as animal, tissues; and how the rooms for preparing the media, the sterilization apparatus, the rooms for inoculation, etc., are identical. Against this, the culture materials differ significantly. Plant tissues are generally cultivated in vessels that are larger than those used for animal cells. Likewise, the instruments for manipulating them are more robust. However, specialists in the culture of plant tissues adopt in certain cases the 'roller-tube method' and the small humid chambers used for animal cells. As for the nutritive media, these also are different. For plant cells they are very simple, while for animal cells they are still based on plasma and chicken-embryo extracts. White insists on synthetic solutions devised by Fisher and himself for the culture of animal cells; but these solutions are more complex than those used for plant cells.

The principal chapters of the book are concerned with methods and the principal types of culture. The author gives concise instructions which ought to be sufficient for a research worker to obtain good results. The methods for animal tissues are considered

apart from those for plant tissues, and the differences between them are made clear. Furthermore, White describes in an appendix several methods suitable for a beginner. A succinct chapter deals with measurements of growth, and the work finally ends with an appraisal of the possibilities of culture methods *in vitro*. This chapter does not pretend to cover the results obtained by this technique, but merely outlines the fields which are pertinent to it: nutrition, cellular metabolism, hormonal correlations, morphogenesis, pathology and even genetics.

Only a particularly competent specialist could write such a concise, and yet complete, book. This excellent work is very timely and will replace older manuals, which are henceforth rendered obsolete.

R. J. Gautheret

WASTAGE AND ITS CONTROL

Deterioration of Materials

Causes and Preventive Techniques. (A Collaboration under the Joint Auspices of the Services Technical Committee of the Department of Defense (Contract No. *N7onr*-29127) and the Prevention of Deterioration Center, Division of Chemistry and Chemical Technology, National Academy of Sciences—National Research Council.) Edited by Glenn A. Greathouse and Carl J. Wessel. Pp. xvii+835. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1954.) 96*s*. net.

REVIEWING a lengthy reference work of this kind might well have been a tiresome business, but for the fact that the authors of the various sections have been successful in presenting a wealth of information in a pleasantly readable manner. As might be expected when so much is packed into such little compass, the data themselves are, in many cases, too brief to be adequate; but, coupled with the copious references and bibliographies which are appended to the various chapters, they provide a valuable introduction to the many aspects of deterioration with which the book is concerned.

In his preface the editor directs attention to the estimate of 12 billion dollars annually as the cost to the United States from all forms of deterioration (excluding that of foodstuffs), a very great proportion of which is attributable to metallic corrosion. It is suggested that "almost any estimate is conservative, for rarely is it possible to put a price tag on man-hours used to combat deterioration". Thus there is ample justification for a book of this kind.

The book commences with a review of world climatic variations, the chemical and physical factors arising from weather conditions and changes and, to complete Part 1, a chapter on biological agents of deterioration; this is a fascinating section in which a reader is tempted to browse. The preservation of various classes of materials such as metals, wood, paper, textiles, leather, plastics, rubber and paint is covered in the next section. It may seem surprising to find paint in this section; but, as the author points out, his is the interest "of the individual who concerns himself with the deterioration of the coating itself", and his philosophy is that the battle against deterioration of a coated article is half won if "we build into the coating the inherent ability to protect itself". Protective measures for electronic, photographic and optical equipment gained much from the experiences of the Second World War, particularly from the problems which arose in connexion with the use of this kind of equipment in the hot, humid climate of the South Pacific.

The drying and maintenance of dry conditions, packaging and the effects of toxins not only on moulds, bacteria, etc., but also as dermatitic agents, form the subjects of the concluding section. Attention is directed to the increasing use of preservatives and toxins for a wide range of materials and the consequently greater exposure of the general population to intimate contact with many complex chemicals. It is suggested that, until a proper evaluation of their toxicological properties has been established, such materials should all be regarded as potential health hazards. Finally, there is a guide to the complexities of United States specifications, including an explanation of the various codes used.

Among the various chapters, by twenty-four different authors, there is some unevenness of presentation both as to style (as would be expected) and also as to intensity of treatment. Nevertheless, the overall result is good, the book is well produced and many of the illustrations are most impressive. Each section concludes with comprehensive references both to the subject-matter in the text and to relevant publications. It is mainly concerned with the American scene; but many of the recommendations and lines of advice have a much wider application, and if followed will undoubtedly lead to the avoidance of very considerable wastage.

NEUROCHEMISTRY

Biochemistry and the Central Nervous System

By Prof. Henry McIlwain. Pp. vii+272. (London: J. and A. Churchill, Ltd., 1955.) 40*s*. net.

WITH the exception of a few honourable but isolated instances, the quantitative study of cerebral metabolism was sadly neglected until the end of the Second World War. More recently, biochemical studies on the brain have proceeded apace in a number of centres, and from Prof. Henry McIlwain's laboratory at the Maudsley Hospital, London, have emerged a series of stimulating papers on the subject. It is fitting, therefore, that Prof. McIlwain should have now written a book which is both a survey of past achievements and a welcome analysis of trends in contemporary research.

The individual chapters are compact summaries of the more important aspects of brain biochemistry. After a section on the overall metabolism of the brain *in situ*, the author gives a comprehensive survey of the experimental work carried out on the labile constituents of brain tissue and their relation to cerebral activity *in vivo*. Then follows a detailed account of the information obtained from studies on the metabolism of brain tissue *in vitro*. A careful distinction is made between the results obtained with cell-containing systems (for example, cortical slices) and those obtained with cell-free systems (for example, homogenates and extracts). Other metabolic features of particular significance in the functioning of the nervous system also receive attention. Such diverse topics as the role of the vitamins and the biochemistry of the transmitter substances are treated in a manner which underlines the

fundamental relationship between metabolism and function.

The reader becomes rapidly aware, however, that, whereas the chemical transformations of carbohydrates and phosphate esters in nervous tissue are known in considerable detail, information about the metabolism and function of the lipids and proteins (which constitute the greater part of the dry weight of the tissue) is sparse. The link between the metabolism of these large molecules and the activity of the brain is a rich field for future study.

Consistent with the broad view taken of his subject, Prof. McIlwain does not hesitate to discuss biochemical lesions associated with nervous dysfunction; the relevant biochemical characteristics of phenylpyruvic oligophrenia and Wilson's disease are among the topics included in the book.

Apart from the rather frequent use of sub-headings, the lay-out of the book is good and the list of references to original papers at the end of each chapter a considerable asset. The index comprises 10 per cent of the total number of pages and is exhaustive. One of the sentences on p. 238 must be a misprint, and a reference to a non-existent table occurs on p. 239. Students of biochemistry and physiology will find the book a most helpful guide to the intricacies of cerebral metabolism.

G. B. Ansell

PHYSICS FOR THE ORGANIC CHEMIST

Determination of Organic Structures by Physical Methods

Edited by E. A. Braude and F. C. Nachod. Pp. xiii+810. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1955.) 15 dollars.

THE extent to which publishers, particularly in the United States, encourage the production of costly monographs on specialized techniques of physical chemistry is now quite disturbing; the comprehensive collection of such books is getting beyond the scope of many chemical departmental libraries in Britain, since consideration must be given to the high probability that their subject-matter may rapidly get seriously out of date. A summarizing volume on modern techniques of physical chemistry, written so as to give weight to methods of permanent value, is thus welcome, and the editors of this book deserve thanks for the way in which they have organized the collected work so as to describe essentially the principles involved and the scope of the results obtainable by applying various types of physical measurements in the elucidation of the structures of organic molecules, wisely advising that detailed accounts of particular apparatus are given literature citations only.

The book is made up of three parts, totalling sixteen chapters, and Part 1, "The Determination of Molecular Size", consists of two chapters on the phase properties of small molecules (H. F. Herbrandson and F. C. Nachod) and the equilibrium and dynamic properties of large molecules (P. Johnson), respectively. In Part 2, "The Determination of Molecular Pattern", there are five chapters: optical rotation (W. Klyne); ultra-violet and visible light absorption (E. A. Braude); infra-red absorption (R. C. Gore); Raman spectra (F. F. Cleveland); and magnetic susceptibilities (C. A. Hutchison). Part 3, "The Determination of Molecular Fine-structure", contains nine chapters on the following subjects: surface films (E. Stenhagen); dipole moments (L. E. Sutton); electron diffraction (J. and I. L. Karle); X-ray diffraction (J. M. Robertson); microwave spectroscopy (E. Bright Wilson and D. R. Lide); thermodynamic properties (J. G. Aston); dissociation constants (H. C. Brown, D. H. McDaniel and O. Häfliger); reaction kinetics (E. A. Braude and J. M. Jackman); and wave-mechanical theory (C. A. Coulson).

The names of the various contributors suffice to indicate the high quality of each section of the work. Many chapters are model essays on their subjects, delightfully readable and admirable for the breadth of their outlook. One can, however, note great differences in the extents to which individuals have visualized the problems which the organic chemists of to-day regard as matters of elucidation of molecular structure. The extremes are the chapters on applications of optical rotation measurements and on visible and ultra-violet absorption spectra and that on applications of wave-mechanics. The former two, written by experimental organic chemists, both show how physical data are of crucial value in determining the configurations of complex organic molecules of all shapes and types, with examples chosen from studies of natural products of recent interest, while the latter deals only with exact bond-lengths and electron distributions in aromatic systems—a topic which to an organic chemist has interest only in connexion with chemical reactivity.

Chapters that deal adequately with the applicabilities of their techniques are those on surface films, dipole moments, X-ray diffraction, magnetic susceptibility and thermodynamic properties. Of these, the last is noteworthy for the way in which it shows the significance of theoretical calculations in relation to conformation problems. The chapter on infra-red spectroscopy is too brief to give more than the physical background of the subject and fails to show its scope. Those on Raman and microwave spectroscopy and on electron diffraction are again highly physical, specializing on geometrical details for quite simple molecules; but of course the scopes of these techniques are essentially limited to the domain of true physical chemistry.

The long chapter on dissociation constants is over-detailed and yet tends to assume that the reader is already acquainted with both past and present theories of chemical polarity and steric hindrance. Again, the essay on chemical kinetics, in attempting to illustrate too wide a subject, assumes a background knowledge of mechanisms of organic reactions. The need for this whole chapter may be questioned, for at the present time most investigators of the kinetics of organic reactions use knowledge of molecular structure to explain details of their reaction mechanisms and not the reverse (for example, in kinetic studies of isotope replacement). In the examples given, the writers do not give due warning of the serious errors that can so easily be made by assuming that any one reaction mechanism has general validity, but do bring forward the main correlatory schemes of proved value.

Considering the extent to which each contributor has had to curtail his subject-matter to his allocated space, the wealth of information of permanent value, the excellence of its typography and, above all, its readability should ensure the book's success.

W. A. Waters

A Monograph of the Clingfishes (Order Xenopterygii)

By John C. Briggs. (Stanford Ichthyological Bulletin—Volume 6 complete.) Pp. iv+224+114 figures and 15 maps. (Stanford, Calif.: Natural History Museum of Stanford University, 1955.) 4 dollars.

THE clingfishes are an order of small teleosts with an adhesive thoracic disk supported by elements of the secondary shoulder girdle and the pelvic fins. While they have no spinous rays, except perhaps in the pelvic fins, features such as the number and arrangement of the branchiostegal rays suggest that the clingfishes have sprung from a spiny-finned (percomorph) stock. But this relationship is surely not "obvious", as is stated on p. 7 of this monograph.

As a result of Mr. John C. Briggs's comprehensive survey, this order is seen to consist of ninety-three species, which can be readily arranged into eight subfamilies of the family Gobiesocidae. Twenty-one new species are described and thirteen new genera proposed, which is some measure of how little was known of these fishes, but also of the importance of this valuable, well-illustrated monograph. But Mr. Briggs's main purpose was to trace ". . . interrelationships—hence the course of evolution—within a well-defined group of fishes, in so far as this is possible by systematic revision of a group in which fossil evidence is not available". Evolutionary trends have been followed by studying particularly the respiratory complex, the single or double nature of the adhesive disk, and the arrangement and form of the teeth. The conclusions on phylogeny are presented in the form of dendrograms—three-dimensional family trees. But in the present work, at least, it is difficult to see any particular advantage in this type of figure.

Except for certain species of *Gobiesox*, all clingfishes are marine, occurring in the coastal waters of the tropical and warm-temperature regions. In the section on distribution which concludes this monograph, two particularly interesting features emerge. The New Zealand clingfish fauna of eight species covering seven genera would seem to consist of endemic relicts, and the sub-family Gobiesocinae is not entirely confined to the New World: there is one species in South African waters.

N. B. MARSHALL

Theory of Ordinary Differential Equations

By Prof. Earl A. Coddington and Prof. Norman Levinson. (International Series in Pure and Applied Mathematics.) Pp. xii+429. (London: McGraw-Hill Publishing Company, Ltd., 1955.) 64*s*.

INCE'S standard treatise, "Ordinary Differential Equations", is now nearly thirty years old, so there is room for a book in English which should revise some of Ince's exposition in the light of modern methods, and extend the field of study to include an account of recent work of importance. This has been accomplished by the present authors, in a terse, compact, closely woven volume; the style is clear but stiff, and the book could scarcely be tackled by even a good honours student before his third year. The language of matrices is employed throughout, and the intending reader must be well acquainted with this language.

After two chapters on existence and uniqueness theorems, there are ten on the linear equation, with a discussion of systems with isolated singularities, and a very thorough treatment of eigen-value and boundary-value problems, singular and non-singular, self-adjoint and non-self-adjoint. The remaining five chapters supply a firm base from which to attack the important topic of non-linear mechanics, on which so much original work has been done during recent years. Asymptotic behaviour, perturbation theory and topological methods lead the reader to the focus of much present-day research; he should derive much profit from this very forward-looking volume. But he should not neglect the problems attached to each chapter; some of these are quite straightforward, but others, adding to and generalizing the text, may present a severe test of understanding. Altogether, this is a noteworthy addition to the McGraw-Hill International Series in Pure and Applied Mathematics.

Fuel

Solid, Liquid and Gaseous. By J. S. S. Brame and Dr. J. G. King. Fifth edition, rewritten by Dr. J. G. King. Pp. xii+551. (London: Edward Arnold (Publishers), Ltd., 1955.) 50*s*. net.

IT is good to see a new edition of this very useful book, especially as the previous edition was published twenty years earlier. As might be expected, such a gap has made necessary the almost complete rewriting of the text, which has taken account of the changes and developments that have occurred in fuel technology in the period concerned.

It is emphasized in the preface that the book deals strictly with the properties of fuels and their methods of application, and not with details of processes of production or utilization of fuels. Nevertheless, there is a lot of helpful information on the latter aspects.

For those unfamiliar with the book it will be necessary to indicate the general scope in a little more detail. The main chapters treat the essential properties of fuels, classification of solid fuels, and give considerable consideration to the classification and composition of coal, followed by discussion of its storage and preparation, carbonization and use for generating steam, power and heat. Next are given details of the various liquid fuels used for heating and power production. There are then three chapters on gaseous fuels, one on fuel analysis, and another on determination of calorific value. The final chapter is concerned with fuel efficiency. At the end of each chapter there are references to further reading.

The volume is of attractive appearance; the matter is well expressed and well printed on good-quality paper, with clear illustrations, and at present prices is very good value. It can be recommended as a very sound text-book.

Fifty Years of Birdwatching

By A. M. C. Nicholl. Pp. xx+127+12 plates. (London: John Murray (Publishers), Ltd., 1955.) 12*s*. 6*d*. net.

MR. A. M. C. NICHOLL is well known as an expert bird-photographer, and he has illustrated this volume of bird reminiscences with some fine examples of his skill with the camera; but this is not a picture book, the illustrations being secondary to the text, which deals with the author's experiences down the years. In a pleasant and chatty manner Mr. Nicholl tells us of much that he has seen and done, often giving us vivid pictures of the English scene and its wild life, coupled with many a shrewd observation on birds and their behaviour.

FRANCES PITT

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, LONDON

PROPOSED EXPANSION SCHEME

Introduction by the College

THE Imperial College of Science and Technology, a school of the University of London, is made up of the Royal College of Science, the Royal School of Mines and the City and Guilds (Engineering) College. It has occupied buildings in South Kensington since 1872. Its present number of students is more than two thousand, of whom some 1,300 are concerned with technology, mainly engineering.

In January 1953 the Government asked the College to raise its student numbers (then 1,650) to 3,000 by 1962. The national need for more highly trained scientists and engineers was urgent then and is more so to-day. Recent statistics have emphasized Britain's deficiency in relation to the Soviet Union, where engineers at graduate level now leave universities and institutes at the rate of 60,000 a year, compared with 22,000 in the United States and 3,000 in Great Britain. For the purpose of the expansion the College was asked to plan on the basis of its taking over the island site, that is, the rectangle south of Prince Consort Road, bounded by Exhibition Road, Queens Gate and Imperial Institute Road.

The decision that the expansion of the College should occur at South Kensington has been generally but not universally approved. Some critics have suggested that a move into the suburbs or the country would have been preferable. This alternative was thoroughly investigated by the College between 1951 and 1953 and, in the end, there was unanimity in favour of expanding in South Kensington. The worst fate which can befall a university institution is to be split for any substantial period between two sites which are far apart. If, therefore, the expansion was to take place outside South Kensington, it would have been essential for the College to give up its existing premises. The difficulty of finding a suitable site of adequate size in the suburbs or near London was very great. Moreover, to build so large an institution in the country would have increased the capital cost enormously through the need to provide so much new residential accommodation. These were important reasons; but the decisive factors were that expansion in South Kensington enabled the College to retain and develop its close ties with the University, with the learned societies and professional institutions, and with the world of science, technology and industry. The decision, taken three years ago, was clearly right and has already led to the investment of nearly £1 million in new buildings on the site.

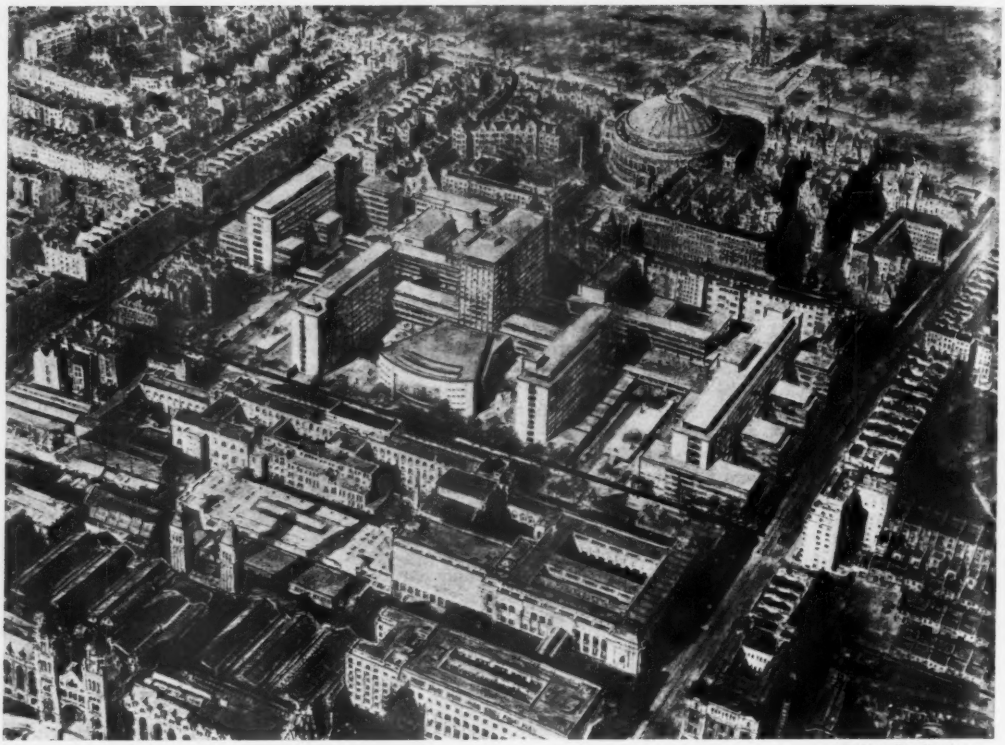
There is another reason for the College remaining and expanding in South Kensington. The surplus funds of the Great Exhibition of 1851 were invested in the purchase of the land which runs south from Kensington Gardens, on the frontage of which the Royal Albert Hall was built later; the Commissioners for the 1851 Exhibition were charged with the duty of using their resources "to increase the means of Industrial Education and extend the Influence of Science and Art upon productive industry". The use of the island site by the College is clearly in line with this requirement and with the intentions of the prime mover in these matters, the Prince Consort, who was indeed the founder and first president of the College.

The College drew up the academic plan for its expansion in 1953. On the basis of this plan it was calculated that the floor area required would be a little more than 1,800,000 sq. ft. gross (that is, including corridors, lifts, staircases and other similar space). This would give a provision of space per person of about 340 sq. ft. (gross) or about 500 sq. ft. per student. This represents an improvement on the crowded state of affairs during 1952–53, but is some way below the space available before the War (1938–39). Space requirements vary greatly according to technical equipment and these are average figures. The calculations also have to take account of the fact that postgraduates need more space than undergraduates, and that the College has the highest proportion of postgraduates of any college or university in Britain. Of the total requirement, about 340,000 sq. ft. can be provided off the rectangle by adaptations to existing College buildings in the Beit Quadrangle and the Royal College of Science building south of Imperial Institute Road. This leaves about 1,460,000 sq. ft. to be found on the island site itself.

The space is to be used as follows. Very large requirements are needed for the engineering departments, the total floor space of which will rise to about 750,000 sq. ft. Science departments, including their technological sub-departments, will rise to 500,000 sq. ft., and mining departments to 175,000 sq. ft. The College's policy is to provide a central building which will contain the common rooms, refectories, libraries and similar units; also a Great Hall. It is clear that there will be no room for residential buildings on the island site; these are to go nearby.

There are certain limitations which have to be taken into account in the planning. First, there are the normal town-planning requirements: the density of population, the angles of light between buildings, fire precautions, a sufficient area for circulation, and so on.

Next come certain special limitations: (1) It is essential that the College should be kept running during the total operation. (2) One of the largest existing buildings is more than seventy years old, and clearly near the end of its useful life; its demolition will have to be carried out as a carefully planned operation, with a progressive moving of the departments concerned into new buildings or transit accommodation. (3) It has been decided to leave intact the Royal School of Mines building and the Goldsmiths' Extension of the City and Guilds College. (4) The Royal College of Music is to be left undisturbed. (5) The development of the south-western part of the site is obscure as it contains private residences not in the College's possession. Moreover, following a request from the Royal Fine Art Commission, in 1955, the College has undertaken to preserve on æsthetic grounds the Norman Shaw house at the junction of Queens Gate and Imperial Institute Road.



Sydney W. Newbery

Fig. 1. Aerial view of the proposed expansion scheme for the Imperial College of Science and Technology, London, from the south-east. Due north is the round dome of the Royal Albert Hall facing the Albert Memorial in Kensington Gardens. Due south is the British Museum (Natural History), showing its four towers. Between this and the proposed new buildings is the Royal College of Science. To the east of the British Museum (Natural History) is the Geological Survey and Museum, and to the north of this is the Science Museum. Exhibition Road passes across the lower, right-hand corner

Messrs. Norman and Dawbarn were appointed architects for the new buildings on the island site in 1953. Mr. Graham Dawbarn presented his plan for the island site at the end of that year and it was afterwards submitted to the University and the University Grants Committee. Detailed drawings have since been made of the buildings to be erected first. The plans have been submitted to the Royal Fine Art Commission, and the 1851 Commissioners. They are now before the Town Planning Committee of the London County Council.

Description of the Scheme by the Architects

The basic scheme to implement the academic requirements of the College on the proposed site was prepared at the end of 1953 and the beginning of 1954. It is this basic scheme indicating the circulation and the general size and massing of the buildings that is illustrated by the model. Since it was made, the model has been altered only in the south-west corner to show the permanent retention of the Norman Shaw house (170 Queens Gate) and the retention for an unknown period of a block of residential property adjoining it (Fig. 2).

Three buildings, all adjoining the northern boundary of the site, are excluded from the new development: the Royal School of Mines and the Goldsmiths' Extension; the Chemical Engineering Building to which a new building—to be known as the Roderic Hill Building—is now being added for that department and for Aeronautics; and, between the two, the Royal College of Music.

The Royal School of Mines and the Goldsmiths' Extension, to which a story has recently been added, is providing essential accommodation and its removal cannot be contemplated in the forseeable future. The Chemical Engineering Building was erected before the War; the Roderic Hill Building is now nearing completion on foundations that were formed some years ago.

The Royal College of Music, which is between the two, is fulfilling a valuable function and has one of the best concert halls in London. The wings that project on either side of it would strictly limit the height and size of any new building on its site. In the distant future it may perhaps be possible to remove it and form a sunken garden on the axis of the steps from the Albert Hall with colonnades at its southern end opening up vistas beyond; if so, drastic treatment will be required to the wings on either side.

The academic requirements necessitate very large buildings. Owing to their uses they are, in fact, large in comparison with their population. While ground space is invaluable in connexion with heavy workshops and other technical needs, some of the buildings must, to achieve the required accommodation with a measure of expansion, be very high.

The object of the Imperial College is not only to train scientists and technologists but also to form a base for education in its broadest sense. This, in London, can best be fulfilled by the students mixing among themselves and the academic staff in debate, in committee, in common rooms and refectories, and in physical and mental recreation all within the site.

The scheme, to achieve its full purpose, should be gracious and open, with sun and air penetrating the buildings and the spaces between them, with vistas from without and within, with large courts, trees, lawns, sculpture and murals so as to create an environment that will bring pride and pleasure to the occupants and to the passers-by, with 'movement' in the skylines and an avoidance of monotony and overshadowing.

The Royal College of Science building, which is to the south of Imperial Institute Road, is part of Imperial College and should be brought into the scheme. Some four or five thousand people will occupy the buildings and others will visit them. There must be adequate provision for car-parking and for vehicle circulation as independent as possible from pedestrian movement.

The buildings themselves should express their purpose and should serve future as well as present needs. They should be so flexible as to permit, over the years, changes in user and a measure of expansion within the scope of the scheme. These requirements make necessary the application of the most recent advances in structural and mechanical design and in the proper use of contemporary materials.

The site lies between relatively wide flanking roads, and a basically symmetrical layout has been found most suitable. The layout consists essentially of five 'spine' blocks, all running from north to south (Fig. 2).

Four of these blocks are 120 ft. high. The spines of the outer east and west blocks are set back some 80 ft. from Exhibition Road and Queens Gate respectively, with, between spines and roads, a series of lower spurs separated by gardens and paved terraces. The central block is 200 ft. high with low wings on either side, and, at its southern end, a Great Hall.

This orientation, coupled with the wide spacing of the high blocks, permits maximum penetration of sun and air, and provides vistas from south to north.

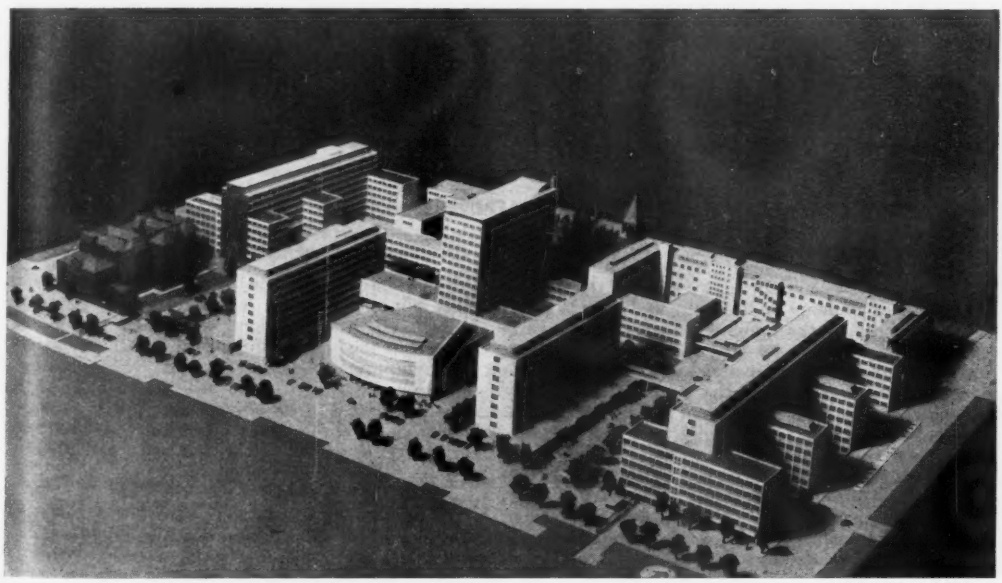
The rise of the flanking roads assists the segregation of vehicles from pedestrians. All vehicles approaching the College enter Imperial Institute Road, which it is hoped will be absorbed as a precinct as shown on the layout drawing and model. They then circulate through the courts and can make use of four traffic lanes. Parking is at the same level; partly in the open and partly under terraces and decks.

Pedestrians enter from Exhibition Road and from Queens Gate by terraces some 85 ft. wide (Fig. 3). They either enter these blocks or pass under them to emerge on to decks above covered parking, facing the central block. From these decks, bridges seventeen feet above the traffic flow lead to the inner blocks and thence on to covered decks which join a central concourse and also open on to the terraces on either side of the Great Hall.

The site has been opened-up to provide a variety of views and vistas. People travelling north along Exhibition Road, after passing two gardens, look through the pedestrian entrance under the spine of the east block to the central block more than 500 ft. away.

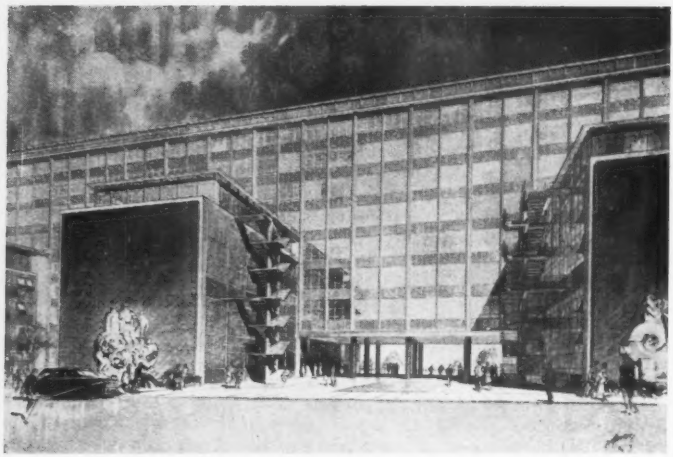
From Prince Consort Road, broad steps just west of the Roderic Hill Building look south past the west bridge to the precinct; one day a corresponding vista may be possible through the Royal School of Mines. If the Royal College of Music is ever pulled down and the site turned into a garden there will be views into the east and west courts on either side of the bastion formed by the north end of the central block—a suitable place for sculptural adornment.

The main blocks (excluding the central one) will all be devoted to teaching and research. The nucleus,



Sydney W. Newbery

Fig. 2. Amended model for proposed expansion scheme, from the south-east. The Royal College of Music (with two towers) is on the north side



Sydney W. Newbery

Fig. 3. Pedestrian entrance for exhibition rooms

composed of the central block with its wings and Great Hall, contains those elements which distinguish university life from technical training. The greatest stress is laid on the fact that these are readily accessible and that libraries, reading rooms, administration, committee rooms, debating halls and facilities for physical recreation adjoin common rooms, cafeterias and refectories. The intimate link between the departments and nucleus might later be extended to the Royal College of Science by means of bridges over the precinct and by covered ways down the edges of the low workshops which are part of the inner east and west blocks.

The nucleus may well serve three or four thousand people at one time. The covered decks under the wings (each some 55 ft. by 120 ft.) contain shops and connect directly with a large common room and with a central concourse within which lifts, escalators and staircases lead to all the components mentioned above. Cloak rooms and sanitary accommodation are necessarily included on a considerable scale; a number of changing rooms and facilities for physical recreation are placed on the lower levels.

The Great Hall is connected with the central block at each of its several levels, but it also has entrances off the precinct and off the terraces to east and west. These terraces are open to the south and are paved for pedestrian use with groups of flowers and shrubs. They rise, by a slight gradient culminating in broad steps, from the vehicle-level of the precinct to the pedestrian-level of the covered decks. The Hall can be used either independently or as part of the College.

The model represents a basic conception. This conception still holds; but is subject to constant analysis, development and refinement. The illustrations which accompany this note express different periods of the evolution and some or all will be amended.

The most advanced work has been done on the outer east and west blocks, which have now been designed in some detail. The remaining buildings have been planned diagrammatically to small scale but have not yet been brought to a stage at which various approvals can be obtained and working drawings started.

The Great Hall, originally planned to hold three thousand, is to be altered; one or more smaller halls will now be provided together with other accommodation. In the southern courts, studies are in progress for providing gardens opening off the pedestrian bridges above parking areas.

MODIFICATION OF RADIATION-INDUCED GENETIC DAMAGE

By Dr. ALEXANDER HOLLAENDER and Dr. R. F. KIMBALL

Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

THERE have been many discussions of the genetic effects of ionizing radiation; and it has often been assumed that the amount of genetic damage is determined inevitably by the amount of radiation. However, in certain circumstances, it is now possible to modify experimentally the amount of genetic damage caused by a given dose of ionizing radiation. Practical applications of this work to human hazards cannot be expected for some time, and the difficulties in predicting the eventual extent of the application are great. Nevertheless, the progress has been sufficient to warrant some optimism. For this reason, it seems worth while to review the major progress that has been made and to suggest directions in which future progress might be anticipated.

At the start, it must be emphasized that the damage done to the genetic material of the cell, the chromosomes, is a hazard not only to future generations but also to the irradiated individual himself. In fact, there are workers who think that chromosomal damage is the cellular basis of all, or nearly all, the symptoms characteristic of over-exposure to radiation. The matter is still the subject of controversy[1], but it seems almost certain that procedures that reduce chromosome damage will also reduce certain types of damage to the body as a whole.

Protective Procedures

A number of protective procedures have been developed against radiation death in micro-organisms and mammals[1-3]. This work is more extensive than that on known genetic effects, and at least some of the procedures probably act by protecting against genetic damage to the cells. Therefore, it was thought

desirable to review some of the important findings as background for the genetic work.

One of the most widely used experimental means of modifying radiation sensitivity is hypoxia. If oxygen tension is decreased to below normal, the sensitivity of the organism to X- or gamma-radiation often decreases proportionally to the decrease in oxygen concentration. There is little change in sensitivity with increase of oxygen tension above normal. Thus the lethal dose (*LD*50) for mice can be changed from about 600 r. to more than 1,000 r. by putting them in an atmosphere of 5–7 per cent oxygen during irradiation[4]. This technique is not readily applicable to man because of the serious consequences of hypoxia. However, the oxygen effect is of great theoretical importance, because it indicates that there are chemical steps between the absorption of the X- and gamma-radiation and the biological damage, and these steps are subject to modification. There appears to be, at most, only a slight oxygen effect with heavy-particle irradiation.

Certain chemicals can be used to reduce the oxygen concentration. One of the most effective is sodium dithionite ($Na_2S_2O_4$), which has a strong affinity for oxygen. This compound protects micro-organisms but is toxic for mammals. One of the first compounds found to protect against death in mammals was cysteine[5], with which it is possible almost to double the *LD*50 for mice. Its protective action can be prevented by keeping animals under a slight positive pressure in high oxygen concentration[6]. This suggests that the chemical may act by decreasing the oxygen concentration in the tissues, though other suggestions have also been made[1].

A number of other compounds (glycols, glucose, succinate, alcohols) cause cells to use up oxygen by stimulating metabolic consumption. These give some protection to micro-organisms and somewhat less to mammals. Their value for protection of mammals does not seem great since they have to be present in fairly high concentration, which may be toxic. Although dangerous to use, compounds that slow down respiration, reduce blood flow, or produce methæmoglobinæmia also have some protective action for mammals, by reducing oxygen concentration in the tissues.

Of a large number of compounds reported to be more or less protective, three seem to have some promise of practical use: namely, cysteine[5], β-mercaptoethylamine (cysteamine)[7], and S,β-aminoethyl-*iso*thiuronium·Br·HBr[8]. All three compounds possess both an —NH_2 group and an —SH group. The presence of both groups, separated by no more than three carbons, has been shown to be very effective[8]. The toxicity of cysteine and cysteamine at the maximally protective concentrations in mammals reduces their usefulness as protective agents. Furthermore, solutions of either are unstable to oxidation. In these respects, S,β-aminoethyl*iso*thiuronium·Br·HBr now appears, at least from studies in this Laboratory, to be the most promising. It is a stable crystalline material, and is effective when given intraperitoneally, intramuscularly, or orally. However, the compound is still sufficiently toxic to warrant considerable caution in its use, especially since most of the results have been obtained with mice. The search for compounds of the same protective power as S,β-aminoethyl*iso*thiuronium·Br·HBr and still lower toxicity is in progress. At least several years work will be required to settle questions pertinent to human application.

Recovery Phenomena

A modest amount of progress has been made during the past few years in finding means of helping the living organism to recover from radiation damage. Such recovery is a normal process, as was learned years ago by noting that mice could tolerate higher amounts of radiation if fractionated instead of single exposures were used. This applies to both lethal and non-lethal physiological effects. It is not certain whether there is actual recovery of damaged cells or simply recovery of the body from the effects of the cell death.

Survival from radiation damage in *Escherichia coli* can be increased if the bacteria are kept, after exposure, at suboptimal temperatures, especially in the presence of certain complete media[9]. These reduced temperatures slow down cell division but still allow some enzyme activity. One interpretation is that cell division utilizes so much of the enzymes and nutritional resources of the cell that the cell cannot synthesize enough of the essential compounds to sustain life. If the cell is permitted to replenish its enzyme supply and redevelop the mechanism of enzyme production before cell division is initiated, then the cell can recover from radiation damage. Evidence for this view is that the cells have a recovery requirement for certain types of extracts, such as yeast or spleen. However, other interpretations are still possible.

Post-irradiation procedures that have proved successful in mice are the transplantation or injection of spleen[10] and injection of bone marrow[11]. The treatment apparently acts by causing the damaged blood-forming tissue to recover; but it is not clear how much of the recovery is brought about by some material given off from the injected tissue and how much by direct replenishment of cells from the transplant. Evidence for functional inter- and intra-species transplantation of bone marrow from unirradiated into massively irradiated animals has been obtained by D. L. Lindsley, T. T. Odell, jun., and F. G. Tausche (*Proc. Soc. Exp. Biol. and Med.*, **90**, 512; 1955); C. E. Ford, J. L. Hamerton, D. W. H. Barnes and J. F. Loutit (*Nature*, **177**, 452; 1956); and T. Makinodan (*Proc. Soc. Exp. Biol. and Med.*, in the press). However, this evidence, though suggestive, does not exclude a non-cellular recovery factor from consideration.

Many attempts have been made to isolate specific recovery substances from non-irradiated tissues; but, in mammals, no effect on recovery has been found. However, in bacteria, cell-free extracts of spleen or yeast were as effective as broth made of these tissues. The extract has been simulated by a combination of three compounds, glutamic acid, uracil, and guanine[12]. As a matter of fact, with certain strains of *E. coli*, the protection by cysteamine is dependent to about 90 per cent on the presence of these so-called recovery factors in the medium in which the bacteria are incubated after X-irradiation[13]. This interdependence of chemical protection and recovery might well be much more general than is now suspected.

It has been possible, by combining several treatments (S,β-aminoethyl*iso*thiuronium·Br·HBr before irradiation, bone marrow immediately after, and daily injections of streptomycin for ten days), approximately to triple the *LD*50 for irradiated mice[14]. However, not all effects of the radiation are equally reduced; for example, mice that recover from high

doses of X-rays as a result of these treatments show early greying and loss of hair. For this reason, it is very important to find out what parts of the spectrum of radiation damage are reduced by a given treatment, and—in the present connexion—especially important to find out how much protection there is against genetic effects.

Chromosome Aberrations

One of the major effects of radiation is breakage of chromosomes. This type of damage has been discussed extensively[15]. Breakage of chromosomes can lead to death of somatic cells and also to transmissible changes in the germ cells. Two main processes are involved—breakage and reunion. According to the classic view, breakage occurs immediately and so can be modified only by treatment before or during irradiation. Reunion often requires considerable time and so may be modified by post-treatment. Actually, the idea that breakage is immediate may be partially incorrect. In any event, it has proved easier to investigate the modification of reunion than the modification of breakage, and the former will be considered first.

The most extensive analysis of reunion has been made by Wolff and his collaborators[16], using the broad bean, *Vicia faba*. They have shown that radiation not only breaks chromosomes but also inhibits reunion. Furthermore, they have demonstrated that the energy mechanisms of the cell are involved in reunion. Reunion can be delayed by enzyme inhibitors that decrease the amount of adenosine triphosphate formed, and accelerated by adding adenosine triphosphate. The importance of this substance and the long time over which the breaks can remain capable of fusing suggest that covalent bonds are involved. The same investigators have evidence for a class of breaks that reunite very rapidly. These breaks may involve the ionic bonds that Steffensen and Mazia[17] suggest exist in chromosomes. The studies of Wolff and his collaborators show that the number of two-break aberrations can be decreased by accelerating reunion through control of the metabolic processes of the cell provided that the radiation is given at a low enough rate.

The success of these or other methods for modifying reunion by post-treatments depends on the time over which breaks remain open and available for reunion. This period seems to be very different for different cells and organisms. For example, breaks have been estimated to remain open for only a few minutes in *Tradescantia* microspores irradiated late in interphase, but considerably longer in the same spores irradiated earlier in interphase[18]. Breaks induced in *Drosophila* sperm are usually stated to remain open until fertilization, although later evidence has been obtained by Baker and Von Halle[19] for some reunion in the sperm. Thus the time available for post-treatment may vary from a few minutes to several hours, or longer, and is probably different even for different tissues of the same individual.

Despite the frequently held view that breakage is immediate, several investigators[21] have suggested that a part of the breakage is not realized until after irradiation. This must be true of any breaks caused by the chromosome 'stickiness' induced by irradiation during mitosis. It would also be true if, as a few investigators have postulated, there are breaks resulting from disturbances in metabolism induced by radiation. However, the most extensive experimental support for delayed breakage is the work of Swanson and his collaborators[21], with infra-red radiation. They have interpreted their results to mean that both X-rays and infra-red radiation induce damage in the chromosomes, which can either be brought to expression by subsequent treatment with the other agent or caused to revert to normal by a heat shock. The occurrence of delayed breaks is still a matter of controversy[22]; but it is of great importance, since numerous possibilities for modifying chromosomal damage by post-treatment may be available if the breakage process really requires considerable time for completion.

In studies of delayed breakage, and other aspects of radiation cytogenetics also, it is often difficult to distinguish effects on breakage from those on reunion; this is very well illustrated by the controversies that have developed over the oxygen effect. Thoday and Read[23] first reported that the number of chromosome aberrations is markedly decreased by irradiating in the absence of molecular oxygen. As pointed out earlier, the effect of oxygen has now been found for many kinds of radiation damage, although it is not universal[24]. The early work by Thoday and Read and by Giles and his collaborators[25] led to the interpretation that part of the chromosome breaks are produced by those products of the radiolysis of water which require molecular oxygen for their formation. This interpretation still has much to recommend it as at least a partial explanation, although evidence has been obtained[26] that seems to rule out one product, hydrogen peroxide, of the radiolysis of water from consideration. Other interpretations of the chemical mechanism of the oxygen effect must also be considered in the light of the demonstration of an oxygen effect in dried materials[27].

Later work has raised a number of difficulties for the hypothesis that oxygen influences the frequency of primary breaks. These difficulties arise from observations that not all classes of aberrations are reduced to the extent expected if only the breakage process were affected. These observations have led Schwartz and Baker[19] to the view that oxygen affects reunion instead of breakage. Swanson[21] has attempted to explain the discrepancies in terms of potential breaks. Wolff and Atwood[16] have shown that the oxygen concentration during irradiation affects both the initial breakage and the subsequent reunion in *Vicia faba*. The matter is still the subject of considerable controversy, as discussions in a recent symposium[28] show.

From a practical point of view, the most important conclusion that can be drawn with certainty is that different classes of chromosomal aberrations in different cells are not affected to the same extent by oxygen. This is emphasized by the observation[29] that hypoxia does not influence the frequency of dominant lethals induced in mouse sperm. It is possible that the sperm of the mouse is normally anoxic and so is uninfluenced by hypoxia of the whole animal. However, it is not certain that this is the explanation, because there is only a small effect of hypoxia on the induction of dominant lethals in *Drosophila* sperm[19], although there is a considerable effect on the induction of other classes of aberrations in sperm and of dominant lethals in oocytes[30]. E. F. Oakberg (personal communication) has found that hypoxia and S,β-aminoethyl*iso*thiuronium·Br·HBr reduce the amount of cell death in mouse spermatogonia.

It has been reported[31] that a number of chemicals (ammonia, S,β-aminoethyl*iso*thiuronium·Br·HBr,

British anti-lewisite (*BAL*), cysteine, sodium cyanide, sodium dithionite and thiourea) are able to reduce the frequency of detectable chromosome aberrations. Several of these chemicals probably act by removing molecular oxygen, but some may act in other ways. The presence of carbon monoxide or carbon dioxide during irradiation increases the frequency of aberrations[20]. The method of action is not thoroughly understood, although the respiratory enzymes of the cell appear to be implicated.

If indirect absorption of energy in the water of the cell is important, then it could be predicted that decreasing the water content of the cell would reduce the effect of the radiation. This seems to be the case in some materials[22]. In seeds of higher plants, water content has a distinct effect[23]; but the frequency of aberrations is greater at very low than at a water content somewhat higher than normal. Within the range of normal water content, the frequency of aberrations increases with increased hydration.

There is a distinct effect of temperature on the production of aberrations[22,23], but the results are complicated by the greater solubility of oxygen at low temperatures. In any event, it seems unlikely that changing the temperature will prove to be a useful procedure for reducing human hazards, although temperature studies may well add to the basic understanding of the production of aberrations.

Mutations

The major genetic changes of concern to later generations, except in relatively limited circumstances, are not gross chromosomal aberrations, but so-called point mutations. Actually, many of the changes in this category are probably small chromosomal losses or rearrangements. Thus the previous discussion of chromosome aberrations applies in large part to mutations as well.

The oxygen effect has been found for a variety of mutational changes, including recessive lethals in *Drosophila*[24] and a nutritional reversion in bacteria[25]. Protection by chemical agents has also been obtained for mutations in bacteria[13] and in *Paramecium* (unpublished work); but several workers have failed to obtain protection with cysteamine and cysteine in mice and *Drosophila*[26]. The facts that the oxygen effect is found for recessive lethals in *Drosophila* and chemical protection has been obtained for chromosome aberrations in plants suggest that there may be difficulties in getting these agents into the germ cells of animals, in unchanged form and in adequate concentration. In any event, it is obvious that there are discrepancies here which must be resolved before general conclusions on chemical protection against the mutational effects of X-rays can be drawn.

The most important question, from the present point of view, is whether mutations occur irrevocably during irradiation or are produced through intermediate steps that require considerable time for completion. There is good evidence that mutation by agents other than ionizing radiation can involve processes which require some time after the original mutagenic treatment has ceased. Thus Auerbach[27], working with the effect of mustards on *Drosophila*, has shown that some mutations do not come to stable expression for a generation or more after treatment. Also, it is known that the mutations induced by ultra-violet radiation are subject to photoreactivation[28] and heat reactivation[29] after irradiation. None of these phenomena has been found to take an important role for mutations induced by ionizing radiation.

However, there is some evidence, admittedly of a controversial or preliminary kind, which suggests that mutation by ionizing radiation, in micro-organisms at least, requires time for completion. Several workers[40] have reported delayed mutations which are expressed only after several generations of vegetative multiplication. At least a part of the phenomena may be the results of phenotypic lag, artefacts of the method of detection, and the peculiar circumstance that newly produced mutants are considerably delayed in division compared to non-mutants and old mutants. However, it is impossible to account for all the observations in this way. Recent work in this Laboratory[8,13] with certain strains of *E. coli* has suggested that the mutation process requires time for its completion. It is observed that various treatments, including post-treatments, which increase survival also decrease mutation to about the same extent. Even when allowance is made for the effects of population density, an influence of oxygen tension on mutation can be demonstrated and, though the analysis is incomplete, it seems probable that there is also a real influence of the post-treatments. Thus these observations suggest that the mutation process requires, for its completion, considerable time after irradiation. During this time it can be modified. The frequency of detectable mutations in *Paramecium* can be decreased by treatment with hydrogen peroxide after irradiation[24] and similar, though not very striking, results have now been obtained for several other post-treatments. Therefore, several pieces of evidence suggest that, at least in some cells, the induction of mutations by X-rays can be modified by treatment after irradiation.

Conclusions

Modification of the physiological damage of ionizing radiation is possible in mammals, and work is under way to apply this finding to man. However, the increased exposures which this protection might allow would have harmful genetic consequences if protection against genetic damage were not also afforded. It therefore becomes desirable to develop methods that protect against both, either by combining methods that, individually, do one and not the other, or by developing methods that will do both. The latter seems particularly feasible if, as seems probable, the cell death responsible for the physiological effects is primarily the result of nuclear damage.

The work on modification of genetic damage is, in some respects, less advanced than the work on physiological damage, and so it would be premature to make definite predictions. However, the prospects are better than many investigators would have dared hope a decade ago. The outlook is best for reducing the effects of foreseeable exposures to X- and gamma-rays since, in this case, pre-treatments could be used. Several successful pre-treatment procedures that give some promise of general applicability are already known. It is less certain that genetic damage can be modified by post-treatment following unforeseen exposures, although promising leads are available and are being investigated. Damage produced by neutrons and other densely ionizing radiations has proved less amenable to many of the procedures that are successful with less densely ionizing radiations, though the

possibilities of post-treatment have not yet been adequately explored. From a practical point of view, keeping the exposure low by physical protection or avoiding the radiation are the only useful procedures at present. However, if the progress of the past decade were to continue, practical methods for reducing genetic damage in other ways might well become available. Meanwhile, this work is developing a better picture of the events involved in the induction of mutations and chromosomal aberrations by ionizing radiations, and so is providing the basic foundation upon which further developments in this field must rest.

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OBITUARIES

Sir Edmund Whittaker, F.R.S.

Sir Edmund Whittaker, emeritus professor of mathematics in the University of Edinburgh, died in Edinburgh on March 24. He had been for some time in failing health; but he retained to the end his mental faculties clear and unimpaired.

Edmund Taylor Whittaker, of a family which he was able to trace back through several generations (the Whittakers of Grindleton, near Clitheroe on the Ribble), was born at Southport on October 24, 1873. He was educated at Manchester Grammar School, and in 1891 went up with an entrance scholarship to Trinity College, Cambridge. In 1895, in a Tripos of great distinction, he was Second Wrangler, bracketed with J. H. Grace and followed by Alfred Young; the Senior Wrangler was T. J. I'A. Bromwich. All four of these men were destined to make a variety of contributions to mathematics. In 1896 Whittaker was elected a Fellow of Trinity College, and in 1897 he was First Smith's Prizeman. His first long paper embodied the results of his thesis, which was on automorphic functions; here, as elsewhere, his inspiration was derived in the first place from Poincaré, whom he placed very high in his pantheon of modern mathematicians.

In 1902 he published his first book, "Modern Analysis", destined in its later editions, from the second in 1915, when he had the collaboration of G. N. Watson, to have a wide influence on the teaching of functions of a complex variable and their various expansions, and almost more on the study of special functions and the differential equations associated with them. To the end of his life he preserved the keenest interest in the functions and partial differential equations of mathematical physics. In 1902 he also discovered his well-known general solution of Laplace's equation, and in 1903 he introduced the now very familiar confluent hypergeometric function, about which quite a literature has gathered. During all this time, with characteristic versatility, he had also been writing on problems of dynamics involving periodic orbits. His second book, "Analytical Dynamics", may be called epoch-making in a very precise sense, in that on the very eve of the era of relativity he summed up in rounded chapters the classical dynamics from Lagrange through Hamilton to Poincaré and Levi-Cività. He

had the gratification, and once at least the surprise, of seeing this work translated into other languages.

In 1906 Whittaker was appointed professor of astronomy in the University of Dublin, under the title of Royal Astronomer of Ireland. Though his duties pertained in a general way to astronomy, it was understood that his chief function was the strengthening of the school of mathematical physics. He therefore gave courses of advanced lectures, one of his pupils, whose future career was not to be in mathematics, being Mr. de Valéra. His principal work of these years, a work of piety and one that entailed an immense amount of reading and historical research, was his "History of the Theories of Aether and Electricity, from the Age of Descartes to the Close of the Nineteenth Century", published in 1910. This, together with its revision and amplification of 1951, and a second volume appearing in 1953 (his eightieth year) and bringing the history up to 1926 (thus just entering the Born–Heisenberg–Jordan–Schrödinger–Dirac period), must be regarded as his *magnum opus*. The last sentence of this second volume reserved for a third volume an account of later developments up to 1950; but this, though the mental power remained, the physical strength was not sufficient to carry through.

On the death in 1911 of George Chrystal, professor of mathematics in the University of Edinburgh, Whittaker was elected his successor, entering on his duties in January 1912. He held this post for thirty-five years, retiring in 1946. In Edinburgh he founded a school of research and, guided in part by the example of Runge in Germany on numerical analysis, a mathematical laboratory, at a time when this was an innovation in universities in Britain. With G. Robinson he published in 1924 a book, "The Calculus of Observations", based on the experience of the laboratory and his own knowledge of this field. Some of the incentive, and a certain part of the material, came from his contact with actuaries in Edinburgh, in particular from his close friendship with the very distinguished actuary, the late Dr. G. J. Lidstone. He will, however, be chiefly remembered in Edinburgh for his teaching, full of inspiration and flawless in delivery; he regarded it as incumbent on him to give lectures to classes at every level. At the same time, he took more than a full share in university administration and in membership of outside bodies.

On the Continent of Europe and in the United States Whittaker was very well known, and indeed kept up an extensive correspondence with mathematicians all over the globe. The mere enumeration of his honorary doctorates, fellowships, visiting lectureships or professorships, presidentships, foreign memberships and other distinctions would exceed the limits of space, and is available in any event in works of reference; much as he valued his well-deserved medals, the Sylvester, the De Morgan, the Copley and others, he appeared to be specially touched and warmed by the honorary fellowship of Trinity College, bestowed on him in his later years and reminding him of his earlier. He was knighted in 1945.

After 1930, when he was received into the Roman Catholic Church, Whittaker's interests turned to natural theology; several of his essays and books of this period, such as "Space and Spirit", have as their explicit aim the reconciliation of modern natural and cosmological science with religion. These preoccupations are a mark of the underlying seriousness of his character. In mind he was clear and rapid to a quite exceptional degree; his capacity for industry was equally beyond the normal; not least he possessed a Roman *pietas*, exercised not only in seeing justice done to the most obscure of his remote precursors in natural philosophy, but also to those close at hand, as when—to choose but one instance—he took up and edited the posthumous manuscripts of Eddington, thus producing the book, "Fundamental Theory". In manner he was unfailingly courteous, yet not formal; entirely accessible and sympathetic.

He is survived by Lady Whittaker, daughter of the Rev. Thomas Boyd and granddaughter of Sir Thomas Jamieson Boyd, of Edinburgh, and by three sons and two daughters. His second son, Dr. J. M. Whittaker, formerly professor of mathematics in the University of Liverpool, is now vice-chancellor of the University of Sheffield. A. C. AITKEN

Prof. A. M. Blackman, F.B.A.

PROF. A. M. BLACKMAN, who died at Abergele on March 9 at the age of seventy-three, was almost the last surviving member of the older generation of British Egyptologists whose researches and publications during the past sixty years have so widely extended our knowledge of Ancient Egypt and early man.

Aylward Manley Blackman was born on January 30, 1883, the eldest son of the Rev. J. H. Blackman, and until he was sixteen was educated privately. He then entered St. Paul's School, whence he obtained a scholarship to Queen's College, Oxford. Under the influence of his father, a keen amateur archæologist, Blackman had at a very early age acquired an abiding interest in Egypt and in archæology, and hence on going to Oxford it was not surprising that he should have read Egyptian, Coptic and Arabic. In 1906, he obtained a first class in Oriental studies.

Blackman's first few years after graduation were busily spent in Nubia and Egypt. During 1907–8 he was one of the assistants of the late Prof. G. A. Reisner on the first of the great expeditions of the Archæological Survey of Nubia and thus obtained practical field-experience in a very hard school. During 1909–10 he helped in the excavations by the University of Pennsylvania at Buhen, slightly to the south of Wadi Halfa, and was solely responsible for the inscriptional work of the expedition. 1910, in fact, was an intensely busy year for him. In that year he was elected Oxford University Nubian Research Scholar and participated in the Oxford Excavations at Faras, a few miles north of Wadi Halfa on the Egypto-Sudan frontier. Almost simultaneously he became one of the international team of scholars engaged in recording those of the Nubian temples that the building of the Assuan Dam threatened to submerge. Between January and May, 1910, by dint of prodigious physical effort and at the cost of sickness the effects of which never left him for the rest of his life, he recorded all the scenes and inscriptions in the temples of Bigeh, Dendur and Derr (all published between 1911 and 1915), and began but never completed the record of the temple of Gerf Hussein.

In 1912, he was elected Laycock Student of Egyptology at Worcester College, Oxford, and in the same year he began, on behalf of the Egypt Exploration Society, the copying of the inscriptions of the important group of rock tombs at Meir in Middle Egypt. His work at Meir occupied the seasons 1912–14,

1921 and 1949–50, and the results were published in a series of six volumes between 1914 and 1953.

In 1934, he was elected Brunner professor of Egyptology in the University of Liverpool, and held this post until his retirement in 1948. Academic and other responsibilities limited his opportunities of visiting Egypt; but 1936–37 saw him once again in the Sudan as director of the Egypt Exploration Society's excavations at Sesebi.

Blackman's main scientific interest was in the religion of Ancient Egypt, particularly its liturgy and ritual. Unfortunately, he never wrote a book on the subject that was nearest to his heart; but his most important contributions to Egyptology certainly lie in the numerous papers which he contributed to the leading Egyptological journals. Typical of these are his massive contributions on such subjects as "Priesthood", "Purification" and "Worship" to Hastings's "Encyclopædia of Religion and Ethics" which still retain all their freshness and value.

He was a magnificent teacher. He liked young people, and his deep knowledge of his subject, coupled with a lively and warm sympathy with and understanding of his students, made him an inspiring teacher. Above all, he was interested in showing that Ancient Egypt was alive: to him there were no dead bones in archæology, and this was reflected not only in his scientific papers, but also in his popular writings, such as his delightful "Luxor and its Temples" (1923), which was also translated into German, his "Literature of the Ancient Egyptians" (1927), a translation of Erman's original work and still the only book of its kind in English, and in his inaugural lecture, "The Value of Egyptology in the Modern World" (1936). Of all British Egyptologists, he was possessed of a real sense of style and language: his translations, even if they had perhaps rather too strong a Biblical flavour, were vivid, accurate and attractive, and his commentaries displayed that same gift of expression allied to deep learning.

Blackman's last years were clouded with tragedy and misfortune. When returning from Meir in 1950 he broke his hip on board ship, and returned home on a stretcher, only to discover that his home had been broken up by the tragic fate of his sisters. Throughout his life he had been peculiarly devoted to his family: this double blow was one from which he never really recovered, and his years of retirement were marked by increasing physical weakness and pain. His election in 1952 as a Fellow of the British Academy was a recognition of his contributions to Egyptology that brought him great cheer in his last difficult years. A great scholar, an inspiring teacher, a very human and kindly man, deeply religious, and in private life the most unselfish and sincere of friends, his death removes one of very great gifts whose place, in his own special field, it will be hard to fill.

H. W. Fairman

Prof. Samson Wright

The sudden death on March 11 of Prof. Samson Wright came as a great shock to his many friends; he was fifty-six years of age.

Samson Wright ('Sammy' to his colleagues) entered the Middlesex Hospital Medical School as a student in 1916 and, apart from one year when he was lecturer in physiology at King's College in 1929, he remained at the Middlesex until his death. After gaining the Gold Medal in the M.B., B.S. examination in 1922, he became senior demonstrator in the Department of Physiology under the late Prof. Swale Vincent, and, after his brief sojourn at King's College, he was appointed as the first John Astor professor of physiology at the Middlesex Hospital Medical School when Prof. Swale Vincent retired in 1930. In 1931 he gave the Oliver-Sharpey Lecture at the Royal College of Physicians on "Certain Aspects of the Reflex Control of the Circulation" and in 1933 he was elected a Fellow of the College.

Wright's services to physiology were many; but there is no doubt that his greatest contribution was as a teacher. Both as a lecturer and as the author of the well-known "Applied Physiology" (first published in 1926 and now in its ninth edition) he was supreme. His vast knowledge, his critical insight and his fluent exposition could make the most difficult topic seem simple, and he had a wonderful gift for stimulating others to think for themselves. He believed that physiology was the corner-stone of medicine, and his classic text-book is a vivid commentary on this theme.

During 1938–49 Wright served the Physiological Society as editor of *Physiological Abstracts*, and during this difficult time he developed it into an indispensable scientific publication.

Samson Wright made notable original contributions to the physiology of the circulation, respiration and the central nervous system. In his early work on the circulation, he was the first to show that ergotamine abolishes the response of the vasomotor centre to sino-aortic afferent impulses. His most important work on respiration was the demonstration with Selladurai that anoxic hyperpnœa is entirely dependent on chemoreceptors, whereas carbon dioxide hyperpnœa is unaffected by sino-aortic nerve section. He also studied the action of acetylcholine and related compounds on chemoreceptors and put forward the hypothesis that acetylcholine might be the transmitter substance in the glomus.

Wright worked with various colleagues for many years on the complex problem of chemical transmission within the central nervous system, and studied the actions of anticholinesterases such as eserine, neostigmine and di*iso*propylfluorophosphonate. They suggested that the differences between the central actions of the first two drugs were due to the fact that eserine is a tertiary compound which penetrates cell membranes easily, whereas neostigmine is a quaternary compound which does not.

Recently he had been investigating the effects of injection of *d*-tubocurarine into various parts of the brain as revealed by electrical wave patterns recorded from different areas.

Apart from his own work, Wright was a most inspiring and enthusiastic director of research, though he was very critical of anything which fell below his own high standards.

Wright had many interests outside physiology. He was an enthusiastic Zionist and he did all that was humanly possible to help those Jewish refugees who came to Britain from Hitler's Germany. After the establishment of the State of Israel, he took a great interest in the Hebrew University of Jerusalem, of which he was a governor. He was also vice-chairman in Britain of the Friends of the Hebrew University. He helped to build up the University's Faculty of Medicine along traditional British lines, and it is most fitting that a laboratory in its Department of Physiology was recently named after him.

In Samson Wright great intellectual brilliance was linked with a most lovable character. He was a formidable but always constructive critic, and he took a constant, unselfish interest in the welfare of his colleagues and staff. His great gift of exposition, combined with humility and sincerity of purpose, made him a most stimulating and delightful companion. His challenging personality will be greatly missed. His wife died in 1950 and he leaves three daughters. C. A. KEELE

NEWS and VIEWS

Mellon Institute of Industrial Research, Pittsburgh : Dr. E. R. Weidlein

DR. EDWARD R. WEIDLEIN retired on March 31 from the presidency of the Mellon Institute of Industrial Research, Pittsburgh, after more than forty years of active work at the Institute. Happily, his retirement will not sever his connexion with the Institute as he will remain on the Board of Trustees and will be available in an advisory capacity in the administration of the various research programmes. His successor as head of the research executive staff of the Institute has not yet been announced. Dr. Weidlein joined the Mellon Institute in 1912, becoming acting director during the First World War and then director in 1921. In 1951 he was appointed president of the Institute and, in addition, he was for four years chairman of the Board of Trustees, a post which he relinquished last year. The Mellon Institute, which is associated with the University of Pittsburgh, is an endowed, non-profit organization, conducting long-term investigations in chemical and physical technology, mainly by a system of industrial fellowships, and it is with this industrial fellowship scheme that Dr. Weidlein has been particularly concerned. However, he has also had many activities outside the Institute, and mention must be made of his work during the Second World War, as head technical consultant in the War Production Board, when he was largely instrumental in establishing the synthetic rubber industry in the United States. In Pittsburgh he is deeply interested in the health, well-being and community development of his home city and its surroundings and, in particular, in the control of industrial pollution. In 1938 the American Section of the Society of Chemical Industry awarded Dr. Weidlein the Chemical Industry Medal, and in 1948 he received the Priestley Medal of the American Chemical Society. He was president of the American Institute of Chemical Engineers during 1927–29.

Imperial College of Science and Technology : Honorary Fellowships

HONORARY fellowship of the Imperial College of Science and Technology has been conferred on the following, all of whom have been connected with the College in various ways : Prof. William Brown, formerly professor of plant pathology ; Prof. Sydney Chapman, formerly professor of mathematics ; Mr. David Garnett, author, and a former student ; Dr. Willis Jackson, formerly professor of electrical engineering ; Prof. J. W. Munro, formerly professor of zoology and applied entomology ; Sir William Penney, director of the Atomic Weapons Research Establishment, a member of the Governing Body and a former student ; and Dr. W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute, U.S.A., and a former student.

Industrial Fund for the Advancement of Scientific Education in Schools

IT was announced last November that seventeen firms had agreed to form an Industrial Fund to assist in the teaching of science in independent and direct-grant schools in Great Britain by the provision of capital grants towards the building, expansion, modernizing and equipping of science laboratories (see *Nature*, November 5, p. 860). It was originally intended to raise £1,500,000 ; but seventy-three more companies have since agreed to support the Fund, and the total now subscribed from all sources is £2,900,000. The committee for administering the Fund has appointed the following four assessors to act as technical advisers both to the committee and to the schools concerned : Sir Graham Savage, formerly senior chief inspector of the Ministry of Education and thereafter chief education officer of the London County Council ; Mr. D. B. Briggs, formerly one of H.M. inspectors of schools ; Mr. W. F. Bushell, formerly headmaster of Birkenhead School ; and Mr. A. G. McKimmie, formerly headmaster of Allan Glen's School, Glasgow, whose special province is schools in Scotland and Northern Ireland.

An architectural brochure of current good practice for the building and equipping of school science laboratories has been prepared, which includes a table of standards of space and cost judged appropriate for the various types of buildings and equipment. It has been decided that, in the main, grants will be restricted to the teaching of the fundamental sciences of physics, chemistry and mathematics, that grants will not exceed two-thirds of the cost of that part of the project which is admissible for consideration, and that priority will be given to schools having 250 or more pupils over the age of thirteen and having at least 10 per cent of them in the mathematics and science sixth forms (the forms after the Ordinary Level of the General Certificate of Education). 439 schools have applied for grants from the Fund, and some interesting statistics have been compiled from their applications. In boys' schools the proportion in the mathematics and science sixth forms is now 50 per cent of the total in sixth forms, and while the total number of pupils over the age of thirteen has increased by more than a third since before the Second World War, there are now two and a quarter times as many boys specializing in mathematics and science. As a result, the facilities for teaching science are overcrowded and inadequate. Unlike maintained schools in Britain, the chief problem for independent and direct-grant schools is not a lack of science teaching staff but one of money for capital projects, and it is for this that the Fund has been created. On the basis of the applications, it has been decided to try to raise a further £600,000 to bring the Fund to a total of £3,500,000, and an appeal will be made shortly for this extra money.

United States National Committee for the Development of Scientists and Engineers

When he announced, on April 3, the establishment in the United States of a National Committee for the Development of Scientists and Engineers, President Eisenhower said: "The National Science Foundation will provide staff services for the Committee and provide leadership to other departments and agencies in carrying forward activities which will contribute to a solution of the problem". The director of the Foundation, Dr. Alan T. Waterman, has recently welcomed this statement and reiterated the important part played by science and technology in the economy of the United States. Dr. Waterman emphasized that the problem of increasing the number of scientists and engineers in the United States is essentially one of educating American youth—a limited amount of education in the sciences for all young people and first-rate advanced training for the small proportion who show the necessary aptitude. Efforts must be made on a local scale all over the country, and the National Committee must stimulate non-Federal groups to encourage State and local approaches to the problem. On the national scale the various agencies of the Federal Government—notably the Department of Defense, Atomic Energy Commission, and the Department of Health, Education and Welfare—are keenly interested in the furthering of science and technology, and the National Science Foundation will co-operate with these agencies in supporting the programme of the Committee.

Scientists for Colonial Research

A question was asked in the House of Commons regarding the steps being taken to implement the proposals of the Advisory Council on Scientific Policy for home-based pools of scientists for use on Colonial problems. The Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, in a written reply, said that such pools have been established at the instance of the Secretary of State for the Colonies at a number of agricultural research institutions and also at certain stations of the Department of Scientific and Industrial Research. Some research on Colonial medical problems is also based on the United Kingdom. A new post is being set up for research on stored products, and two pools of scientists have recently been enlarged.

Re-development of the British Museum Library

The Advisory Council on Scientific Policy in its seventh report supported proposals for a central reference library in London or for a national science lending library, and for a science centre, of which they would form part. These proposals were not mentioned in the debate on the new British Museum Library, usually referred to as the National Library, which Mrs. L. Seger raised on the adjournment in the House of Commons on April 10, though they are related to that scheme in so far as the discarding of literature more than fifty years old is concerned. Mr. J. R. Bevins, replying for the Government, stated that under the present plans the first relatively small stage of re-development of the British Museum Library would not take place before about ten years, and that the second stage was not expected to start before 1975, and would probably be later. It would seem from these comments that the Government has no present intention of implementing the proposals for a science centre and its related library facilities.

Advisory Council of the Commonwealth Scientific and Industrial Research Organization

The following have been appointed new members of the Advisory Council of the Commonwealth Scientific and Industrial Research Organization, Australia: Prof. N. S. Bayliss, Chemistry Department, University of Western Australia; Dr. A. R. Callaghan, director of agriculture, South Australia; Prof. H. R. Carne, professor of veterinary pathology and bacteriology, University of Sydney; Mr. T. A. Frankcomb, Tasmanian fruit- and hop-grower; Mr. A. McCulloch, chief engineer, Southern Electric Authority of Queensland; Prof. W. W. Macfarlane, Department of Physiology, University of Queensland; Mr. M. A. Mawby, vice-chairman of Consolidated Zinc Pty., Ltd., and commissioner of the Australian Aluminium Production Commission; Mr. W. W. Pettingell, general manager, Australian Gas Light Co.; Mr. W. J. Russell, Western Australian grazier; Mr. E. M. Schroder, managing director, Adelaide Cement Co., Ltd.; Mr. H. B. Somerset, managing director, Associated Pulp and Paper Mills, Ltd.; Prof. A. D. Trendall, master of University House, Australian National University; Prof. J. S. Turner, Botany Department, University of Melbourne; and Dr. J. Vernon, senior executive officer, Colonial Sugar Refining Co., Ltd.

The Scientist and Society

An address, "The Dilemma of the Scientist", given on August 25 by Dr. J. Bronowski at the annual conference of the International Liaison Committee of Organizations for Peace, held in The Netherlands at Oosterbeck, has been published by the National Peace Council as No. 59 in the series of Peace Aims Pamphlets (pp. 10. London, 1955; 9*d*.). Dr. Bronowski points out that the main responsibility for the dangers which confront the world to-day rests on the peoples and governments and not on the scientist as such, who is not the keeper of the nation's policy. He is, however, the keeper of his own personal conscience, and Dr. Bronowski urges that governments have a duty to make it possible for the scientist to exercise his conscience and decline to participate in particular projects which are distasteful to him. Dr. Bronowski points out that, once a scientist touches the fringe of a secret subject, it is practically impossible for him to withdraw. The scientist's great responsibility, he argues, is to see that the public is sufficiently well informed on the scientific issues to vote wisely and thus secure sound decisions of policy; and a government has a further responsibility to see that scientists have the opportunity to speak freely on such issues. Dr. Bronowski concluded his address by indicating briefly the way in which the continuance of science itself as well as of a free society depends on the preservation of this right of discussion and dissent.

World List of Biological Periodicals during 1950–54

Under the title "Biological Sciences Serial Publications: A World List, 1950–1954", *Biological Abstracts* has published for the United States Library of Congress a list of biological periodicals that appeared during 1950–54 (pp. 270. Philadelphia: University of Pennsylvania, 1955; 2 dollars). Publications devoted entirely to medical and applied

aspects of biology have been largely omitted, as it has been estimated that if all the serials containing material on biological topics, both pure and applied, were to be included, the total number might exceed by five times the three thousand five hundred titles in the present list. The serials are grouped under five broad headings and, where possible, are subdivided according to country of origin. These headings include: general biology, botany, zoology, science of man, and general science publications containing contributions on biology or a significant number of biological papers in each issue or volume. Bibliographical details include title, issuing agency and publisher, date of first issue, frequency of publication and contents. The material comprising the regular features of a publication is classified and described as original research, analyses (including review literature and summaries of original research), proceedings of societies, conferences and congresses, abstracts, bibliographies, popular notes and book reviews. The value of this useful list would doubtless have been greatly enhanced had it included the World List abbreviations of each of the periodicals cited.

Old Akkadian Tablets from the Middle East

A CONSIDERABLE number of clay tablets have come into the possession of the Chicago Natural History Museum, and they have been deciphered by Prof. Ignace J. Gelb in *Fieldiana* (Anthropology, **44**, No. 2; 1955). The writing is Old Akkadian, and internal evidence would suggest that they date to some period during 2261–2199 B.C. The tablets resemble closely some published and unpublished examples which bear the dates of Narâm-Sin and Šar-Kali-Šarrī. Unfortunately, the new tablets were obtained from an Arab, and their exact provenance will never be known. But once again internal evidence would point to the Diyala river region, and this agrees with the meagre information obtained from the Arab. The tablets (except the last two, which are letters) are texts of legal and business interest. Usually at the top are a number of proper names, and these are presumably the witnesses of the transaction given below. While they cannot be said to be exciting reading, as naturally we know nothing of the people or of the transactions, the general picture of the ordinary life and business of those times is very interesting. One of the letters at the end of the book is concerned with the slackness of a person named Ginunu who, it seems, has stopped sending bread for the soldiers. No reasons are given; but one can perhaps suppose he was a contractor of the type which has existed at all ages, and doubtless he duly sent in his bills to the head commissariat for the total amount of the bread. The volume as a whole is beautifully published, all the tablets being reproduced in half-tones.

Curtis's Botanical Magazine: Index

THE Royal Horticultural Society, London, has rendered a service that plant lovers will appreciate by the publication, under the authorship of F. J. Chittenden, of an index to Vols. 1–164 of *Curtis's Botanical Magazine*. There is also an appendix of the titles and numbers of plants from Vols. 165–170. To quote a comment in the preface: "There is little doubt that a complete set of the Botanical Magazine provides the most comprehensive and probably the most accurate collection of plant-portraits in existence though for convenience and speed of reference there has long been a need for a consolidated index to the illustrations". This very considerable task has now been completed. A major aim of providing accepted contemporary nomenclature throughout has added much to the value of the volumes that have appeared since the inception of the *Magazine* in 1787. The index and history, amounting to 282 pages, can be obtained from the Royal Horticultural Society, Vincent Square, London, S.W.1; price £2 2*s*.

Chromosome Numbers in *Oxalis*

THE genus *Oxalis*, comprising some eight hundred species, occurs principally in South America and South Africa, though some, such as *O. acetosella*, are cosmopolitan. Chromosome numbers in species of the genus have already been reported on by various investigators. The basic numbers cover a fairly wide range, namely, 5, 6, 7, 9, 11—7 being apparently the commonest. In a contemporary paper on this subject by G. E. Marks (*New Phytol.*, 55, 1, 120; 1956), the chromosome numbers of an additional twenty-six species have been ascertained, sixteen of these being of South African origin. The new data admit of cytological comparisons being made between species from the two major regions. From the total information now available the author concludes that it is possible to separate cytologically the South African from the South American group of species, the former having no variation in chromosome size, little variation in basic chromosome number but a high degree of polyploidy, while the latter group has variability in chromosome size and basic chromosome numbers with relatively little polyploidy. Using this evidence, together with morphological and ecological data, it is postulated that the South African group of *Oxalis* species is a specialized group within the genus.

The Manchester Museum

THE report of the Manchester Museum for 1954–55 is a record of quiet but steady progress made in the face of financial stringency. The rising costs of salaries and wages necessitated a restriction of all other expenditure to the lowest possible figures. Notwithstanding such an atmosphere, all departments report progress and much valuable research was carried out and published by the staff. As usual, an impressive series of twenty museum lectures was arranged for Saturday afternoons, with an average attendance throughout the year of sixty-five. At the annual reception the Museum welcomed about three hundred guests, and the idea of showing them special displays of recent acquisitions and illustrating the scientific and technical work done in the Museum is to be commended.

Commonwealth Fund Fellowships

THE Committee of Award of the Commonwealth Fund Fellowships has made the following elections, among others, for 1956–57: *General Fellowships*: H. G. Alexander, Aberdeen, Christ Church, Oxford, and Manchester (philosophy); J. A. Beardmore, Sheffield (genetics); J. S. Cumpsty, Durham (mining); Miss Marion Fairman, Durham and Glasgow (bacteriology); W. Galbraith, Birkbeck College, London (physics); Miss Janet Graham, St. Andrews (botany); N. Macleod, Imperial College, London, and Leicester (chemistry); J. McDaniel, Imperial College, London (engineering); J. N. Murrell, King's College, London, and Corpus Christi College, Cambridge (physics); H. M. A. Onitiri, London School

of Economics (economics); D. F. Shaw, Manchester (chemistry); J. G. Taylor, Christ's College, Cambridge (mathematics). *Home Civil Service Fellowships:* E. Y. Bannard, Ministry of Transport and Civil Aviation; A. A. Bellamy, Ministry of Housing and Local Government; R. W. Howe, Department of Scientific and Industrial Research; E. H. Simpson, Ministry of Education. *Oversea Civil Service Fellowship:* W. J. A. Payne, Fiji (animal climatology).

University of London: Appointments

The following appointments have been made in the University of London: M. W. Humphrey Davies, reader in electrical engineering in the Imperial College of Science and Technology, London, to the University chair of electrical engineering tenable at Queen Mary College; Dr. E. Shotton, senior lecturer in pharmaceutics in the School of Pharmacy, London, to the University chair of pharmaceutics tenable at that School; Dr. O. S. Heavens, lecturer in the University of Reading, to the University readership in experimental physics tenable at the Royal Holloway College; Dr. H. B. Henbest, lecturer in organic chemistry in the University of Manchester, to the University readership in organic chemistry tenable at King's College; Dr. J. C. Pugh, senior lecturer in the Department of Geography, University College, Ibadan, to the University readership in geography tenable at King's College; and Dr. A. J. B. Robertson, lecturer in physical chemistry, King's College, to the University readership in physical chemistry tenable at that College.

Oversea Service Division, Colonial Office

The following appointments have recently been made in the Oversea Service Division, Colonial Office: J. D. Broatch (deputy director of agriculture, Gold Coast), director of agriculture, Gold Coast; E. J. Butler (senior agricultural officer, Northern Region, Nigeria), principal research officer, Northern Region, Nigeria; I. W. Hughes (plant pathologist, Bermuda), assistant director of agriculture, Bermuda; R. A. Kitching (agricultural officer, Gambia), senior agricultural officer, Sierra Leone; L. N. H. Larter (senior botanist, Federation of Malaya), chief research officer, Federation of Malaya; H. K. Ashby, E. J. H. Berwick, J. Cook, W. N. Scott and H. J. Simpson (senior agricultural officers, Federation of Malaya), senior agricultural officers, grade A, Federation of Malaya; J. B. G. S. Staub (sugar technologist, Mauritius), registrar, Central Board, Mauritius; D. G. Cumming (senior assistant conservator of forests, Northern Rhodesia), conservator of forests, Northern Rhodesia; D. H. L. Rollinson (veterinary research officer, Uganda), chief veterinary research officer, Uganda; O. S. Barr, agricultural officer, Uganda; J. V. Huhta, mining geologist, Sierra Leone; W. J. Bell, special grade medical research officer, West African Council for Medical Research; A. J. MacLeod, veterinary research officer, Federation of Nigeria; A. C. Brooks, biologist, Game Department, Uganda.

Announcements

The Earl of Iveagh, chancellor of the University of Dublin and Trinity College, will open the reconstructed Iveagh Geological Laboratory in the College on May 10.

The Right Hon. Sir David Eccles, Minister of Education, will open the extensions to the Northampton Polytechnic, London, on May 7.

Mr. G. H. C. Amos, a principal in the Ministry of Agriculture, Fisheries and Food, has been appointed agricultural and food adviser to the High Commissioner for the United Kingdom in Ottawa.

The Development Commission is offering two or three training grants to British honours graduates for training in research problems in marine or freshwater science, which is designed to fit them for employment either in the Fishery Research Service of the Ministry of Agriculture, Fisheries and Food and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £250–£350 a year, with allowances for university fees, etc., and are tenable for one year initially, renewable up to a maximum of three years. Application forms, to be returned by May 20, and further information can be obtained from the Secretary, Development Commission, 3 Dean's Yard, London, S.W.1.

The annual conference of the Electron Microscopy Group of the Institute of Physics will be held in the University of Reading during July 24–26. Papers on all aspects of electron microscopy, both theoretical and practical, together with applications of the instrument are invited. Further information can be obtained from the Assistant Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

A conference on the science and technique of photography, organized by the Scientific and Technical Group of the Royal Photographic Society, will be held on May 12 in the Institute of Physiology of the University College of South Wales and Monmouthshire, Cardiff. The conference will be open to all, without admission ticket. Further information can be obtained from the honorary secretary of the Group, R. J. Cox, Ilford, Ltd., 134 St. Albans Road, Watford, Herts.

The Electronics Section of the Scientific Instrument Manufacturers' Association is holding an exhibition on "Atoms, Electrons and Industry" in the Royal West of England Academy, Bristol, during June 6–8. Twenty-nine firms will be participating and also the Atomic Energy Authority, Harwell, and the University of Bristol. The aim of the exhibition is to acquaint industrialists with the progress being made by British instrument firms and, by showing applications already in use by some industries, to stimulate other industries to find further uses for these new tools. Admission will be free, by ticket only, applications for which should be made to the Association, 20 Queen Anne Street, London, W.1.

An international light metals convention will be held at the Montanistische Hochschule, Leoben, Austria, during June 7–9, when, as in the case of the previous two conventions there in 1934 and 1948, a survey will be given of the present state of the development of light metals. Lectures will be given by leading experts from Europe, Canada and the United States, and will cover the following fields: light metals in the national and world economy; metallurgy of light metals (aluminium and magnesium); the development of titanium; technology of light metals; metallography and physics of light metals; and the application of light metals. A programme has been published, and this and further information can be obtained from the Geschäftsstelle der 3 Internationalen Leichtmetalltagung, Leoben/Stmk., Austria, Montanistische Hochschule, Institut für Metallkunde.

ATOMIC SPECTROSCOPY

SYMPOSIUM AT THE ARGONNE NATIONAL LABORATORY

DURING February 15–17 a symposium on spectroscopy was arranged by the Argonne National Laboratory, Lemont, Illinois, which is one of the research centres (administered by the University of Chicago) of the United States Atomic Energy Commission. Many contributors to the meeting were either members of the Commission or were doing work under contract for it; but the symposium was concerned with non-classified subjects of optical research and gave an opportunity for seeing current developments in the United States.

Emphasis at the meeting was put on general research rather than on spectrochemical techniques. However, a few papers dealt with such problems. D. W. Steinhaus (Los Alamos) discussed the problems of a high-resolution spectroscopy laboratory when radioactive materials are involved. The view that the poor reproducibility of the porous-cup source is caused by inhomogeneous porosity of the graphite was expressed by M. Slavin (Brookhaven); quicker and more reliable results have been obtained by use of water cooling and a lacquer coating. A paper on the spectrographic determination of oxygen in metals (in particular, iron) was presented by R. W. Tabeling and V. A. Fassel (Iowa State College), who showed that with d.c. carbon-arc excitation and argon as an internal standard, reliable results (to about 20 p.p.m.) can be obtained.

L. Wilets (Los Alamos) discussed isotope shifts and nuclear structure, and pointed out there are three main observations which theory should explain. The observed shifts are on the average too small, show regular variations with neutron number and exhibit even–odd staggering. A possible explanation for these experimental facts may be connected with compressibility and deformation of the nucleus. W. M. Cloud, J. E. Mack and J. A. Vreeland (Wisconsin) discussed experimental isotope shift data for palladium-46, cadmium-48, tin-50 and tellurium-52. L. E. Owen and D. C. Manning (Goodyear Atomic Corporation) described the narrow wave-length interval direct-reading spectrometer being built on the principle of conversion of photoelectric currents into pulse counts. Techniques used by F. S. Tomkins and M. Fred (Argonne) for spectroscopic examination of small radioactive samples were outlined; such methods include high-frequency discharge sources and porous electrodes, and the spectra are obtained on a 30-ft. Paschen–Runge grating mounting.

The nuclear dipole moment (μ) and the electric quadrupole moment (Q) have been determined by T. E. Manning, M. Fred and F. S. Tomkins (Argonne) from consideration of the hyperfine structure of certain lines and a partial term analysis of americium-I and -II. The values are given as $\mu = +1{\cdot}4$ nm. and $Q = +4{\cdot}9 \times 10^{-24}$ cm.^{2} for the isotope 241. The corresponding quantities from isotope 243 agree within 1 per cent. J. G. Hirschberg (Wisconsin) described a photoelectric method for examining, with the use of a Fabry–Perot interferometer, the Lamb shift in ionized helium (excited from a liquid-helium cooled source). A similar investigation on lead isotopes has been carried out by J. Brody (Argonne), who also discussed the relative effectiveness of metal and dielectric coatings in interferometers. Isotopic analysis of polonium-208 and -209 mixtures by measurements of intensities of band heads from the molecules $(^{208}Po)_2$ and $(^{208}Po\ ^{209}Po)$ was discussed by D. J. Hunt and G. Pish (Monsanto). V. W. Cohen (Brookhaven) pointed out that optical methods for studying nuclear properties should still be considered together with the more modern techniques such as those involving microwaves and atomic beams; he gave a list of radioactive elements which could profitably be studied. G. W. Stroke (Massachusetts Institute of Technology) and F. H. Sullivan and D. K. Rice (Jarrell-Ash) gave theoretical and experimental criteria for measurement of the performance of a diffraction grating and maintained that wave-front interferograms give most information on this matter.

Studies of hyperfine structure are sometimes rendered difficult because the lines are broadened by the Doppler effect. F. Bitter (Massachusetts Institute of Technology) discussed general methods of overcoming this problem by such means as atomic beams in electrodeless discharges at low pressures. A method involving coincidence counter techniques was proposed by P. L. Sagalyn (Massachusetts Institute) for considerably reducing the effect; the photons of two lines are simultaneously detected by coincidence techniques, and the difference in wavelengths is independent of the Doppler effect. If a mercury arc is placed in a magnetic field, the wavelengths of the hyperfine structure components of the lines emitted are a function of the field. One of the components can be used as a variable wavelength source for the study of hyperfine structure in absorption. H. H. Plotkin and J. E. R. Young (Massachusetts Institute) gave papers in which this technique was used for the study of the mercury $^3S_1$ state and the resonance lines of mercury radioisotopes, respectively; a similar principle was used by P. L. Sagalyn for some radio-frequency experiments in the mercury $^3P_1$ level.

A session on term analysis was opened by G. H. Dieke (Johns Hopkins University), who discussed a semi-automatic method for spectroscopic wavelength and intensity measurement; the spectral lines are displayed on an oscilloscope screen and the comparator readings recorded electronically, much of the tediousness and strain of measurement being thus eliminated. L. F. H. Bovey (Harwell) described a furnace which can be used for obtaining the absorption and emission spectra of neutral atoms of radioactive elements such as plutonium. The analysis of praseodymium-I was discussed by S. P. Davis (Massachusetts Institute), who emphasized the use made of Zeeman patterns (taken at fields of 79,000 oersteds) of neutral atoms excited by an electrodeless microwave discharge source. The lines were recorded on an echelle spectrograph. Similar experiments on erbium have been carried out by J. W. Lindner and S. P. Davis (Massachusetts Institute). C. C. Kiess and R. Zalubas (National Bureau of Standards) gave details of a comprehensive programme being carried out on thorium-I. The term analysis of this atom may show when the *5f* electron enters the configuration of valence electrons in the heavy elements. Some twelve thousand lines have been measured in this work, and while not all are thorium-I, it is estimated that it will take at least three years to finish the analysis. In

describing the application of new techniques to Zeeman spectroscopy, P. M. Griffin and K. L. Vander Sluis (Oak Ridge) showed how a combination of electrodeless discharge sources, very uniform magnetic fields of about 33,000 oersteds and an echelle spectrograph can produce very well-resolved Zeeman patterns; results off the plates were obtained with the aid of a high-speed electronic computer (Oracle).

H. H. Nielsen and K. N. Rao (Ohio State University) discussed measurements connected with the theory of centrifugal stretching constants in linear polyatomic molecules. The results from an analysis of the absorption spectrum of thallous chloride taken with a Fabry–Perot interferometer crossed with a 21-ft. grating instrument were given by R. R. Kadesch, J. C. Moldenhauer and J. G. Winans (Wisconsin), and G. W. Charles (Oak Ridge) discussed the vibrational analysis of the spectrum of Po_2. The use of absorption and fluorescence spectra to derive the symmetry of the micro fields about europium ions in methanol (C_{2v}) and in water (D_{2h}) was described by S. Freed, E. V. Sayre and D. G. Miller (Brookhaven). Further results from the polarization, absorption and fluorescent spectra of single crystals at temperatures between 4° and 300° K. of some praseodymium and europium salts obtained by Freed and Sayre give much information on the micro-crystalline fields surrounding the ions.

After a discussion of the derivation of selection rules for rare-earth ion spectra in crystals, R. A. Satten (University of California) showed how these are violated in the spectra of neodymium bromate and ethyl sulphate. The breakdown in the selection rules is partially attributed to interaction of electronic and vibrational motion. The possible electronic configuration of the Am^{+3} ion was briefly discussed by J. G. Conway, R. D. McLaughlin, B. B. Cunningham (Berkeley) and D. M. Gruen (Argonne) following a description of the experimental absorption (over the range 3000–12,000 A.) and fluorescent (range 3000–8800 A.) spectra of single crystals of lanthanum chloride containing 0·04 and 0·2 mole per cent americium chloride. The Raman spectrum of uranium hexafluoride and the infra-red spectra of neptunium hexafluoride and plutonium hexafluoride have been observed by J. K. Brody, H. H. Claassen and B. Weinstock (Argonne), and all six fundamental frequencies arising from the O_h symmetry determined. The absorption spectra of the last two fluorides have also been studied between 5000 and 25,000 A., and an interpretation of the fine structure seen in some of the bands was discussed.

K. W. Meissner and E. C. Finckh (Purdue University) discussed the possible use of a calcium atomic-beam lamp for high-precision measurements of wave-length. A half-width of 9×10^{-3} cm.$^{-1}$ was observed in preliminary experiments. A complete and consistent set of oscillator strengths for dipole transitions from the ground-level of the helium atom were given by W. F. Miller and R. L. Platzman (Purdue). From a study of the unusual Doppler effects in calutron ion sources, J. R. McNally, jun., and M. R. Skidmore (Oak Ridge) showed that these should be attributed to an ordered ionic drift about the arc column with ion velocities often exceeding 10^6 cm./sec.

The use of nuclear magnetic resonance to determine isotope ratios ($^1H/^2H$ and $^6Li/^7Li$) was summarized by B. E. Holder and M. P. Klein (California). The techniques described included both a relative and an absolute method. The natural $^7Li/^6Li$ ratio was found to be 11·8. The same authors also discussed measurement of nuclear magnetogyric ratios by nuclear magnetic resonance. Where direct observation is not possible because of such causes as residual atomic paramagnetism, nuclear quadrupole interaction, low abundances or small magnetogyric ratios, a double resonance technique can be tried. In this method the atom under investigation is bonded to an atom with more favourable properties. Under suitable conditions, by an indirect spin–spin interaction, the constants of the unknown atom can often be determined. L. S. Goodman (Argonne), in a paper on atomic beam measurements of radioactive isotopes, discussed problems connected with the source, magnetic field, calibration and detection.

Much of the work discussed was in the course of publication or had been published, and therefore no arrangements were made for issuing any detailed account of the symposium. L. F. H. Bovey

PHYSIOLOGY OF FUNGAL PARASITISM

STUDIES of the physiology of fungal parasitism, begun by Prof. W. Brown many years ago at the Imperial College of Science and Technology, are being maintained and extended, special attention being given to the part played by the enzymes which bring about the dissolution of the cellular structure and the death of tissues. In the *Annals of Botany* (**20**, 77; 1956) three investigations are reported. J. S. Cole gives an account of the pathogenicity of *Botrytis cinerea*, *Sclerotinia fructigena* and *S. laxa*, with special reference to the action of their pectolytic enzymes. He has found that although these three fungi cause rotting of apple tissue and the death of the protoplasts, very little pectolytic activity can be detected in the rotting tissue.

Pectolytic activity was measured by methods involving (*a*) maceration of plant tissues, (*b*) viscosity and reducing group determinations in pectic substrates, (*c*) increase in acidity of pectin. By these methods it was shown that pectolytic enzymes were produced by all three fungi in synthetic media. With *S. fructigena*, which was the only fungus studied in detail, replacement of glucose by pectin increased the formation of pectolytic enzymes. When various apple extracts were used as culture media, little or no pectolytic activity was detectable. With all three fungi the presence of apple juice in a culture medium, which by itself was suitable for enzyme formation, resulted in the suppression of pectolytic activity. Oxidized apple juice had a pronounced effect in deactivating certain pectolytic enzymes, an effect which was especially marked with *B. cinerea*. This points to an interaction between the pectolytic and oxidizing systems and introduces a new line of approach to the study of the biochemical interaction between host and parasite.

R. K. Singh and R. K. S. Wood, in an investigation of the production and properties of the pectic enzymes secreted by *Fusarium moniliforme*, have observed that this fungus secreted macerating enzymes in liquid media only when these contained certain natural extracts, pectic substances, or galacturonic acid. Apple extract was unsuitable for enzyme secretion and also inhibited enzyme secretion in synthetic

media otherwise suitable. Protopectinase activity of solutions was highest in the *p*H range 8·0–9·0, was rapidly lost at temperatures above 50–60° C., and was reduced by concentrations of phosphate higher than 0·02 *M*. The enzyme was partially purified by precipitation in 60 per cent acetone at *p*H 6·0. Protopectinase solutions also contained an enzyme which reduced the viscosity of solutions of various pectic substances. The properties of this enzyme were, in general, similar to those of protopectinase. When activity of enzyme solutions was measured by the liberation of reducing groups, pectate solutions were more rapidly degraded than were solutions of a high methoxyl pectin, particularly in the early stages of the reaction. Partition chromatography of the products formed showed that pectate and pectin were degraded in different ways. Although the pathogen readily secreted protopectinase in potato extract, potato tubers were not readily parasitized. In contrast, *Fusarium avenaceum*, which readily attacked tubers, secreted little protopectinase in potato extract.

S. C. Gupta has examined the production of pectolytic enzymes by *Pythium de baryanum*. Among other things, he observed that the incorporation of sodium chloride in a synthetic medium stimulated the pectolytic activity of cultures of *Pythium de baryanum*. The chloride ion appeared to be mainly responsible for this effect; on the other hand, presence of the calcium ion depressed enzymic activity. Glucose, fructose and mannose were about equally suitable for growth and enzyme production. Sucrose, if used as sole carbohydrate source, gave good mycelial growth but poor enzyme production; but if a small proportion was replaced by glucose, enzyme production was as good as on glucose itself. Galactose gave very poor growth and negligible enzyme production. For optimum production of pectolytic enzyme, glucose (or fructose or mannose) requires to be autoclaved in a somewhat alkaline medium—very conveniently with the dipotassium hydrogen phosphate or potassium phosphate of the nutrient medium. A yellow to brown coloration (due to caramelization) is produced in the process; but the stimulating factor is not bound up with the colouring substance. The same stimulating effect on enzyme production was obtained by adding to the nutrient medium a small quantity of glucose which had been dry-heated at 150° C. for 20 min. Partition chromatographic analysis suggested that the stimulating substance was probably glyceraldehyde, though it is not excluded that other breakdown products of sugars may also play a part.

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

REPORT FOR 1954–55

THE fifty-fourth annual report of the Executive Committee of the Carnegie Trust for the Universities of Scotland, covering the academic year 1954–55*, records an increase in the numbers of students from 1,408 to 1,502, chiefly in science and medicine, to whom assistance was given with their class fees, the amount expended increasing from £22,007 to £24,232. Problems created for the Trust by the bursary awards made by local education authorities in terms of the Education (Scotland) Act are by no means solved, and the Executive Committee directs attention to the, apparently, growing assumption of many students that the Carnegie Trust grant is to be applied for as an addition to the education authority bursary whatever be the value of that bursary. Strongly emphasizing its declared intention to limit its assistance in this direction to holders of local education authority bursaries whose circumstances, taken as a whole, appear genuinely to warrant additional help, the Executive Committee expresses its desire for a proper appreciation of this policy and the reasons for it on the part of directors of education, university advisers of studies and similar officials.

Expenditure on the Trust's research scheme totalled £33,155, and its various features were maintained. Three senior scholarships and fifty-three scholarships were awarded or renewed, some being supplements to scholarships and bursaries gained from other sources, and twenty-three of these were used for postgraduate study outside the parent university. The high value of this part of the programme is stressed in the report, as is that of the scheme, inaugurated in 1950, which affords annually ten members of university staffs, more than thirty years of age, the opportunity of study abroad. Eleven such awards were made in 1954–55, three being in scientific subjects, two in medicine and one in African studies. Besides the annual grant made to the Royal Society of Edinburgh and to the *Scottish Historical Review*, eleven learned societies in Scotland were assisted in the publication of their transactions and journals; in addition to an immediate grant of £2,000 to the Scottish National Dictionary, the Scottish Dictionaries Joint Council was invited to submit plans by which £20,000 could be used for ensuring substantial developments within a reasonably short period, and this sum has been placed at the Council's disposal. Repayments by former beneficiaries declined slightly from £1,921 from thirty-six former beneficiaries to £1,868 from thirty-three beneficiaries.

Besides particulars of grants made under the ninth quinquennial distribution, October 1, 1952–September 30, 1957, there are appended the terms of the scheme for the endowment of postgraduate study and research and a summary of reports received from the advisers to the Trust on the work of investigators under the research scheme during 1954–55. In the mathematical, physical and engineering section, the fellowships of R. Giles on quantum field theory at the Institute of Theoretical Physics, Copenhagen, and of D. Chisholm on the flow of two-phase mixtures at the University of California are stressed as outstanding. K. M. Swanson's work on nuclear magnetic resonance was again successful, and in connexion with J. V. Thomson's work in fluid dynamics it is suggested that the Scottish universities should co-operate to provide an electronic computer with the strong support of the Carnegie Trust.

In the chemistry section, J. S. S. Reay, working on organic ammonium derivatives of montmorillonite, has noted interesting relations between the molecular volume of the ammonium ions and the adsorptive capacity for hydrocarbons. J. M. Beaton's work at the Royal Technical College, Glasgow, has been instrumental in establishing the constitution of taraxerol; also, by establishing the orientation of the carboxyl group in glycyrrhetic acid, he has com-

* Carnegie Trust for the Universities of Scotland. Fifty-Fourth Annual Report (for the Year 1954–55) submitted by the Executive Committee to the Trustees on 20th February, 1956. Pp. iv+72. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1956.)

pleted the determination of its stereochemical configuration and has effected the first direct conversion of a member of the ursane triterpenoid group into an isomer of the oleanane group. Miss H. Kerr's successful work on the algae of the highest life zone of the shore at the Marine Station, Millport, and G. K. Wallace's work, in the Anti-Locust Research Centre Laboratory of the Entomology Department, Oxford, on the influence of light and of observable objects on the movements of locusts, are also noted, as well as that of Dr. S. M. Marshall and A. P. Orr on the distribution, anatomy, reproduction, development and life-cycle of the small crustacean *Calanus finmarchicus* (Gunnerus). Continuing his gravity survey in Scotland, Dr. J. Phemister covered the whole of Fife and Scotland south of the Forth–Clyde, and W. G. Jardine continued his researches at Cambridge on the relation between shore-lines and river-valley development, with particular reference to the Southern Uplands. D. H. Mackenzie commenced a structural and petrological study of the granite and associated rocks of Mid-Strathspey, and D. I. Smith a similar study of the third ring dyke complex of Ardnamurchan.

The usual lists of publications by fellows, scholars and recipients of grants and of awards under the research scheme during the year are also appended, together with the financial accounts.

FLOW OF VISCOUS LIQUIDS IN BRANCHED TUBES

WITH REFERENCE TO THE HEPATIC PORTAL VEIN

By Dr. C. H. BARNETT and Dr. W. COCHRANE

Department of Anatomy and Department of Physics, St. Thomas's Hospital Medical School, London

THE existence of independent stream-lines within the hepatic portal vein[1] may account for the localization of disease processes within certain parts of the liver[2]. Before conclusions drawn from animal experiments can be applied to man, however, anatomical and physiological differences need to be considered. In different species, the tributaries and branches of the vein vary with respect to diameter and angle of junction; moreover, the relative rates of flow and viscosity of the circulating blood probably show species variations. To investigate the significance of these differences, experiments have been carried out on non-turbulent flow for the following typical junctions: a minor branch leaving a straight main tube; a minor tributary joining a straight main tube; and major and minor tributaries uniting to form a main tube. The aim has been to determine the region of the main stream which feeds the branch in the first case, and the region of main stream receiving from the tributary in the second and third cases. Some answer can then be given to the question: What are the chances that particles (bacteria, malignant cells, etc.) suspended in the blood leaving an organ and entering the portal vein will be eventually directed into a particular region of the liver?

The liquids used were (1) water and (2) 40 per cent glycerine in water (specific gravity 1·100), referred to below as 'glycerine'. The viscosities of these liquids at room temperature (19°–21° C.) were (1) 1·0 and (2) 3·5 centipoises, approximately that of human blood[3]. The tubes were of 'Perspex', cut and drilled as necessary, and cemented together so as to give sharp internal edges at the junctions. Unless otherwise stated, the internal diameters of the main tube and the wide and the narrow branches or tributaries were 10, 8 and 6 mm., respectively. The lengths of all the tubes from the junction were sufficient to ensure that the steady parabolic velocity profile was usually at least 99 per cent developed. By means of a large opal lamp and a lens, the system under investigation was projected on to a white screen and measured at a magnification of × 8. Corrections for optical distortion were applied. No elaborate investigation of the scaling of tube dimensions has been attempted, but it appears that the results are valid for other dimensions of tubes if the ratio of diameters remains unchanged. When flowing in tubes of diameter exceeding 0·4 mm., blood can be regarded as a continuous medium[4].

For flow into a branch from a straight main tube, the apparatus is shown in Fig. 1*a*. Flow-rates were adjusted by constricting the two exits. The position of a stream-line in the main tube was shown by a fine line of coloured liquid (Evans blue) from a quill tube, the position of which was controlled by a micrometer screw. When the rates of volume flow, Q_s in the branch and Q_m in the lower part of the main tube, were steady, the position of the coloured stream-line was adjusted until it just failed to enter the branch. The distance x of this critical stream-line from the wall of the main tube was measured (Fig. 1*a*). Graphs of Q_s/Q_m against x were drawn, x being expressed as a percentage of the diameter of the main tube. Some results are shown in Fig. 2. Each curve is the result of thirty or more observations and is probably accurate to ± 5 per cent. The results were independent of the total flow-rate. It was concluded that, for a given value of Q_s/Q_m, the chances that particles in the main tube remote

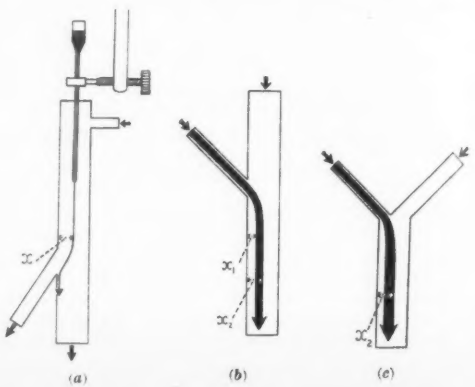

Fig. 1

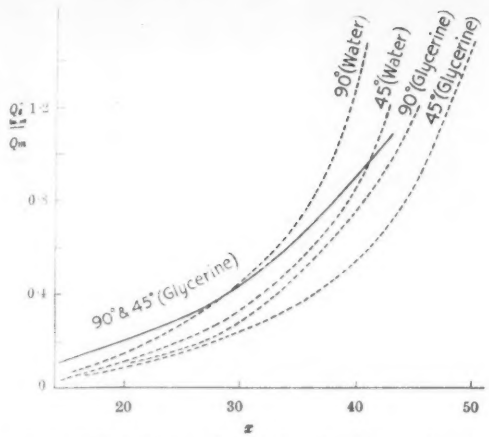

Fig. 2. Critical distance x for wide (——) and narrow (- - - -) branches, different angles and viscosities

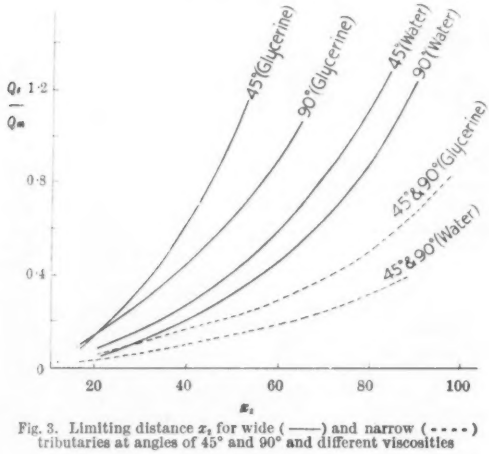

Fig. 3. Limiting distance x_2 for wide (——) and narrow (- - - -) tributaries at angles of 45° and 90° and different viscosities

from the branch will pass into it are greater with increasing viscosity and decreasing width of the branch. The angle of outflow is of little significance when the values of Q_s/Q_m are those likely to occur in the portal venous circulation.

For inflow from a tributary to a straight main tube, the apparatus is shown in Fig. 1*b*. The flow-rates, Q_s of the coloured liquid in the tributary and Q_m in the upper part of the main tube, as well as the distances x_1 and x_2, were measured. With glycerine, x_1 was usually zero unless the ratio Q_s/Q_m was very high: this measure is therefore not discussed here. The value of x_2 was measured about 6 cm. below the junction; here the coloured tributary stream was nearly always flowing parallel to the axis of the main tube. Graphs of Q_s/Q_m against x_2 were drawn, x_2 being expressed as a percentage of the main tube diameter (Fig. 3). In contrast to the findings for outflow, the values of x_2 depended on the total flow-rate Q_t ($= Q_s + Q_m$). However, when Q_t exceeded 100 ml./min., the results were effectively independent of Q_t. This flow corresponds to an average velocity of 2·1 cm./sec. and, since lower velocities would not be physiologically important[2], only the experimental results for the higher values

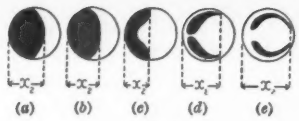

Fig. 4

of Q_t are given in the graphs. It was concluded that, for a given value of Q_s/Q_m, the chances of particles from the tributary passing far across the main tube are greatest when the tributary is narrow, the liquid is of low viscosity and (in the case of wide tributaries) when the angle of junction is large.

Finally, we considered major and minor tributaries uniting to form a symmetrically placed main tube. The apparatus is shown in Fig. 1*c*. The major tributary and the main tube were 10 mm. in diameter; the minor tributary was 8 mm. ('wide') or 4 mm. ('narrow'). The rates of flow in the major and minor tributaries ($Q_{maj.}$ and $Q_{min.}$) and the distance x_2 was measured (Fig. 1*c*). The significance of x_2 requires further explanation, since—except at high values of $Q_{min.}/Q_{maj.}$—the liquid from the minor tributary spread out on entering the main tube. This is shown in the cross-sectional diagrams of Fig. 4 *a* . . . *e*, which correspond in that order to a decreasing series of values of $Q_{min.}/Q_{maj.}$. The distance x_2 is thus the limit of penetration across the main tube *as seen in profile*. The lower portions of the curves in Fig. 5, where the slope is negative, correspond to this circumferential spreading, which occurs for most physiologically important values of $Q_{min.}/Q_{maj.}$. The total flow-rate Q_t ($= Q_{min.} + Q_{maj.}$) is of considerable importance; the effect of altering the total flow, using wide tributaries at 90°, is shown in Fig. 5. A similar effect was observed using narrow tubes or 45° junctions. With water, the circumferential spreading was found to occur at lower values of $Q_{min.}/Q_{maj.}$ than with glycerine. For a given value of $Q_{min.}/Q_{maj.}$, the chances of particles

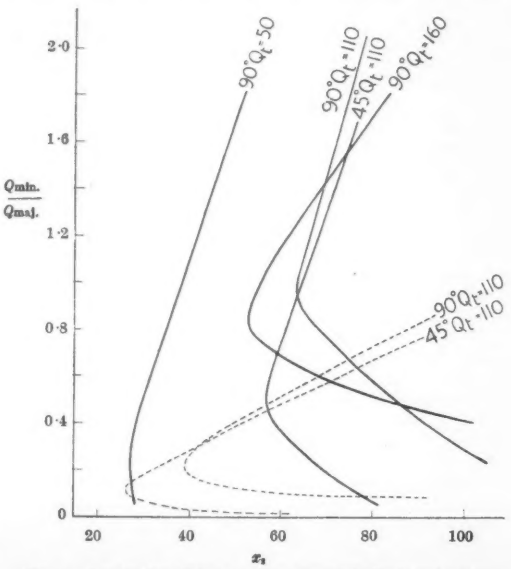

Fig. 5. Penetrating distance x_2 for symmetrically joined major and minor tributaries, using wide (——) and narrow (·····) minor tributaries, differing angles and three rates of total flow (Q_t); glycerine throughout. The curve - - - - is qualitative only

from the minor tributary passing far across the main tube are greater when the angle of junction is large (Fig. 5). In flow conditions simulating those within the portal venous system, the circumferential spreading is especially marked when the diameter of the minor tributary is large, the ratio $Q_{min.}/Q_{maj.}$ low and the viscosity of the liquid high.

Physical explanations of the experimental curves will be discussed later.

To summarize, it may be said that when the blood-flow within the hepatic portal vein is compared in different species, the following principles should be borne in mind: (1) At the liver hilum the angle of branching of the portal vein is immaterial. For a given ratio of the rates of flow in the main vessel and a branch, a narrow diameter branch is more likely to withdraw particles from far across the main vessel than is a wide one. (2) The manner of formation of the portal vein is important. Where it is formed by a tributary joining a straight main vein, as in Fig. 1*b*, particles are more likely to pass across the portal vein when the rate of flow in the tributary is large and its diameter small. The converse is true where the portal vein is formed by the symmetrical union of a major and minor tributary, as in Fig. 1*c*, unless the rate of flow in the minor tributary is very high. In both types of junction more crossing-over of the streams occurs when the angle of union is large than when it is acute.

[Aug. 12

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FINE STRUCTURE OF THE INSECT RETINULA AS REVEALED BY ELECTRON MICROSCOPY

By Dr. HUMBERTO FERNÁNDEZ-MORAN
Nerve Ultrastructure Department, Venezuelan Institute for Neurology and Brain Research, Caracas, Venezuela

In the course of electron microscope studies of the compound eye of insects, interesting structural details of the visual cells forming the retinula have been observed, which bear relation to the complex functional properties of these light receptors.

The percipient portion known as the retinula at the base of each ommatidium consists of a group of generally seven or eight elongated visual cells, arranged so that their differentiated medial borders (rhabdomeres) form together the central rhabdom or optic rod occupying the longitudinal axis of the ommatidium[1] (Fig. 1,*a*). An analysis of the submicroscopic organization of these receptor elements was carried out by electron microscope examination of ultrathin (200 A.) serial sections of whole insect eyes fixed with osmium tetraoxide and embedded in methacrylate. In view of the tough chitin components of the insect eye, a diamond knife[2] had to be used for routine serial sectioning.

In transverse sections through an ommatidium of the eye of the house-fly (*Musca domestica*), the seven rhabdomeres of the corresponding retinula cells appear as dense round or oval bodies, 1–2 microns in diameter, which are grouped in a regular pattern around the light granular central region (Fig. 1,*b*).

Each rhabdomere is surrounded by a double membrane (approximately 200 A. thick), and most of these elements show a characteristic internal laminated structure represented by twenty to thirty transverse dark lines alternating with light spaces, with a regular period of approximately 500 A.

Serial sections indicate that this transverse lamination corresponds to corrugated and perforated membranes running generally parallel to the long axis of the rod-shaped rhabdomere (Fig. 1,*c*). In addition to this predominant type of longitudinally oriented lamination, the other rhabdomeres in each ommatidium exhibit a distinct fenestrated structure (Fig. 1,*d*) formed by a network of intersecting oblique transverse dark lines. This characteristic appearance in cross-sections may correspond to fenestrated disks arranged with their planes perpendicular to the rhabdomere axis (Fig. 2,*c*).

In longitudinal sections through a rhabdom, the two main types of internal structure can be readily recognized in adjacent rhabdomeres (Fig. 2,*a*) separated by the clear central space containing fine filaments and a granular material. The most common texture encountered is represented by a fenestrated membrane with a roughly hexagonal framework of dark lines in which an axial periodicity of approximately 600 A. can be detected (Fig. 2,*b*). This characteristic structure probably corresponds to the longitudinally oriented membranes described in the transverse sections (Fig. 1,*b*).

The second type of structure appears as a system of regular transverse light bands alternating with dark bands (approximately 600–700 A. in thickness), each of which is delimited by two dark, segmented lines (Fig. 2,*c*). These dark bands can be interpreted as representing perforated disks arranged perpendicularly or obliquely to the long axis of the rhabdomere.

Each of the rhabdomeres constituting a rhabdom exhibits a slightly different, characteristic fine structure; but as a group they are nevertheless organized in certain basic patterns. Thus, in transverse sections (Fig. 1,*b*) the six external rhabdomeres symmetrically distributed around the central rhabdomere (*D*) can be grouped into three pairs of elements which are similar in shape, size and internal structure. These paired rhabdomeres are usually located diagonally opposite to each other (Fig. 1,*b*: *A*1, *A*2; *B*1, *B*2; *C*1, *C*2).

The differentiated submicroscopic organization of the rhabdom depicted on the basis of these preliminary findings suggests a correlation with the functional differentiation of the retinula cells which

has been postulated in order to account for the remarkable capacity of insects to discern the plane of polarized light and to orientate themselves by it[3]. According to the investigations of Autrum[4], the visual cells of each ommatidium may perform the functions of radially placed analysers for polarized light. The highly regular submicroscopic laminated structure of the single rhabdomeres described here might well furnish the structural basis for the optical properties (such as textural birefringence of the composite laminated and fenestrated bodies, combined with the intrinsic birefringence of its components) which are required of such an analyser for polarized light.

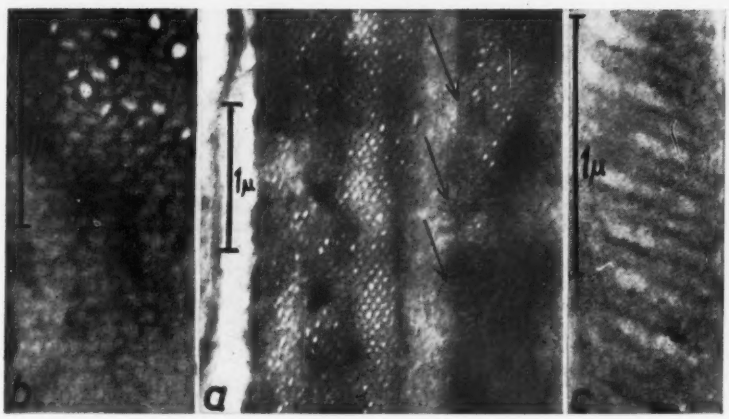

Fig. 2. Electron micrographs of longitudinal sections of rhabdomeres. (*a*) Longitudinal ultrathin section of two rhabdomeres of the house-fly eye with fenestrated structure and transverse lamination (arrows). × 22,000. (*b*) Longitudinal section of a rhabdomere showing the regular fenestrated framework of the membrane. × 29,000. (*c*) Longitudinal section of a rhabdomere with transverse laminated structure. × 39,000

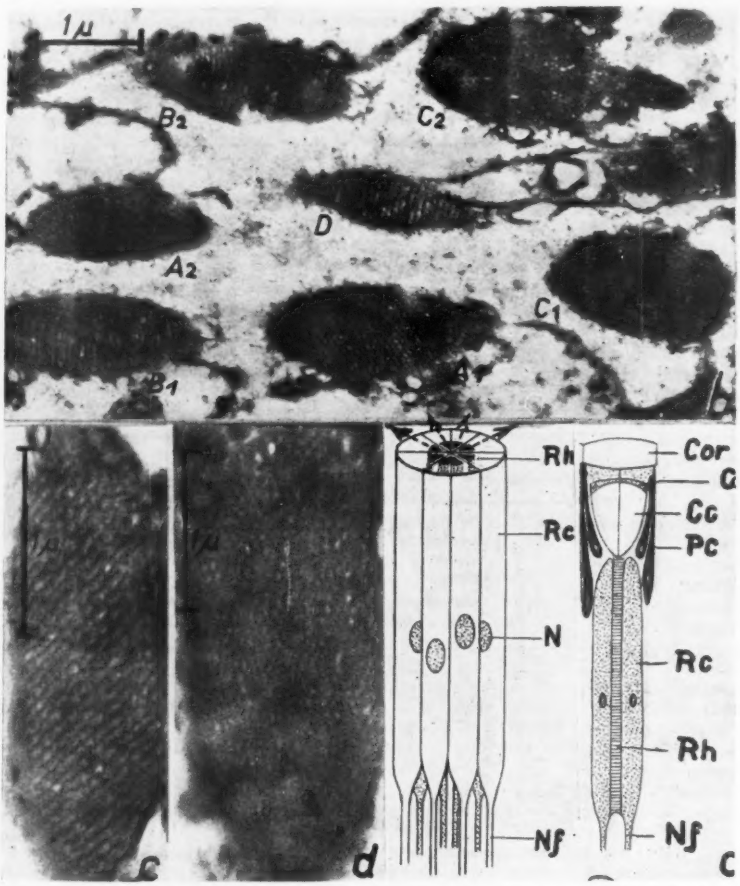

Fig. 1. (*a*, lower right) Schematic diagram of a longitudinal section through an ommatidium showing the visual cells (*Rc*) with the rhabdomeres. (According to Grenacher and Hesse) Electron micrographs of : (*b*) transverse ultrathin section through the rhabdomeres of an ommatidium from the house-fly eye. × 16,000 ; (*c*) transverse section of a rhabdomere with oblique transversal lamination. × 28,000 ; (*d*) transverse section of a rhabdomere with fenestrated internal structure. × 24,000

Moreover, the characteristic distribution pattern of the rhabdomere pairs would provide a spatial arrangement adequate for the proposed functions of a compound analyser ascribed to an ommatidium.

The same general type of fine structure has been observed in the rhabdomeres of all other insects examined so far (the honey bee, *Apis melliflora*, *Ercbus* and other tropical Lepidoptera and Odonata). The transverse laminated structure of the receptors in the visual cells of insects described here is similar in some respects to the submicroscopic disks found in the external segments of the rods and cones of the vertebrate retina[5]. Further details of the rhabdomere texture and of their association with specialized submicroscopic tubules, as well as their characteristic structural relationship with the components of the optic ganglion, will be published elsewhere. [Feb. 18

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Atomic and Astronomical Time

A CÆSIUM atomic resonator[1] has been in operation as the standard of frequency at the National Physical Laboratory for eight months and its performance under a variety of conditions has been investigated. It has been found that the electrical and mechanical conditions required for an accuracy of repetition of $\pm$ 5 parts in 10^{10} are easily attained, and it is expected that the model now being designed for routine operation will give an accuracy approaching $\pm$ 1 part in 10^{10}.

During this investigation many changes were made to the cæsium beam chamber; but it was nevertheless found possible to calibrate the quartz standard under specified conditions at regular intervals of about one week. The results of the calibration, given in Fig. 1*a*, are based on the value of the cæsium frequency determined in June 1955[1]. The actual values are not therefore of particular interest, and it is only the variations with which we are here concerned. The National Physical Laboratory quartz clock *Q*13 was chosen for these measurements, because it had been in operation for three years with a uniform rate of change of frequency of 3·5 parts in 10^9 per month and appeared, therefore, to be one of the most stable of existing timekeepers. It is seen that for a further period of six months the rate of change was almost constant at the same value, but that it then changed to 1·5 parts in 10^9 per month. No reason for this change could be found.

The determination of the rate of the clock in terms of astronomical time is somewhat complicated[2]. For its time determinations, the Royal Greenwich Observatory is able to use all the most reliable clocks in Britain by means of a continuous interchange of information between the different laboratories, and *Q*13 is one of the clocks used in this way. Details of its calibration in astronomical time could therefore be supplied by the Observatory, and it was not necessary to wait for the publication of time signal corrections, as would normally be necessary for precise measurements. The results obtained with the different clocks are combined to give a mean clock, the rate of which is determined by observing the times of star transits. This mean clock can then be used to give the performance of the individual clocks. The values for *Q*13 supplied by the Observatory one month in arrears are given in Fig. 1*b*. The curve of Fig. 1*c* is obtained by subtracting the ordinates of Fig. 1*b* from those of Fig. 1*a*, and it thus represents the variations of the unit of astronomical time in terms of the cæsium standard. The maximum variations of $\pm$ 4 parts in 10^9 agree well with the estimate of the accuracy of the Observatory time service made by Smith[3].

It is customary for the Observatory to make a new assessment of the unit of time after a period of six months, when the clock performances and the stellar observations can be viewed in retrospect. This has not yet been done for the period in question; but a special reassessment was made at the end of January, using the results obtained over a long period with a group of nine quartz clocks. The results given in Fig. 1*d* show a considerable improvement in uniformity. This uniformity is mainly a function of the clock performance, only the general slope of the line being determined by the astronomical measurements. Finally, in Fig. 1*e* are plotted the monthly means of the star observations in terms of the cæsium standard (Smith, H. M., and Tucker, R. H., private communication). The results give an indication of the variation in the rate of rotation of the earth, although the scatter of the points about a mean curve is probably due to the instrumental errors associated with the astronomical observations.

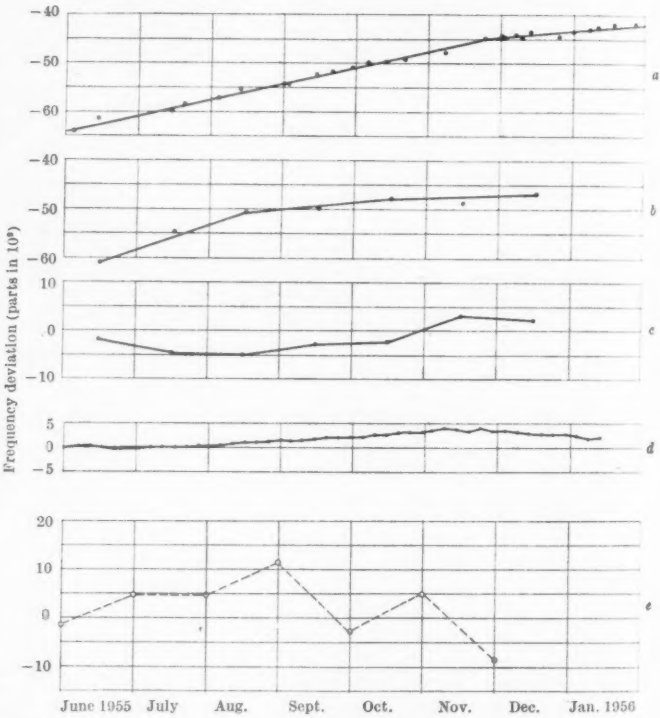

Fig. 1*a*. Frequency deviation of *Q*13 in terms of the cæsium 3·0–4·0 resonance, based on the frequency of the cæsium resonance measured in terms of the Royal Greenwich Observatory monthly current value of *Q*13 in June 1955.

Fig. 1*b*. Frequency deviation of *Q*13 in terms of the Royal Greenwich Observatory monthly revised values.

Fig. 1*c*. Royal Greenwich Observatory monthly revised values in terms of cæsium.

Fig. 1*d*. Royal Greenwich Observatory reassessed values, based on astronomical observations and the mean of nine quartz clocks, in terms of cæsium.

Fig. 1*e*. Astronomical observations in terms of cæsium.

A mean curve would agree fairly well with the periodic variation predicted from the observations of previous years.

Another important result of the investigation was the gradual realization that when the most suitable conditions of operation had been found, and the novel techniques mastered, the cæsium resonator became a remarkably simple instrument to use. There can be no doubt that this or some other atomic standard will revolutionize the technique of determining the unit of time, and will in practice be used to make the unit available, however it may be defined.

We are glad to acknowledge the co-operation of Mr. H. M. Smith and Mr. R. H. Tucker of the Royal Greenwich Observatory in supplying the astronomical data.

L. Essen
J. V. L. Parry

Electricity Division,
National Physical Laboratory,
Teddington, Middlesex. Feb. 14.

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Gelatin Light-scattering, by a New Enzymic Digestion Technique

In applying light-scattering techniques to molecular-weight and dissymmetry measurements for gelatin fractions in solution, serious doubts arose concerning the efficiency of the usual clarification methods (ultrafiltration, high-speed centrifugation). A convincing check of clarifying processes existed only for fractions of low molecular weight, where the experimental value of the dissymmetry, Z, should approximate to the theoretical value, unity, if all suspended impurities have been removed. For higher molecular weights, a solution free from impurities would be expected to give Z greater than 1, and the procedure adopted by other workers has been to repeat the clarification until Z became constant. It was suspected that this limit did not correspond with complete clarification, and that the use of this criterion caused significant errors in the 90° scatter (and M_w) and large errors in the values of Z.

The alternative, and novel, procedure was therefore adopted of measuring the light scattered from a solution which had been given only a moderately effective clarification, and then destroying the gelatin macromolecules by adding a solution of Armour crystalline trypsin. The residual scatter was mainly that of the solvent and the impurities, since the digestion products of the gelatin, and the added trypsin, have negligible scatter. Subtraction of the residual scatter from the original figures then gives the scatter due to gelatin alone, so that the molecular weight and true dissymmetry of the dissolved gelatin may be obtained. The effects of the addition of trypsin may be seen in Table 1.

In this experiment the gelatin solution was forced by air pressure (2 lb./sq. in.) through a '5 on 3' sintered glass disk into the metal semi-octagonal cell (capacity 50 ml.), held at 40·0° C. At the time '0·50 hr.', 2 ml. of the trypsin solution (concentration 10 mgm. per 100 ml. water) was pipetted into the cell. The trypsin solution had also been filtered through a '5 on 3' sintered glass disk. After 24 hr. a further 2 ml. of the trypsin solution was added, and the scatter increased by 2 per cent at each angle.

Table 1

Time (hr.)	Scatter (arbitrary units) at 135°	90°	45°	Apparent dissymmetry ($\lambda = 546$ mμ)
0	26·0	12·0	32·0	1·23
0·50	26·0	12·0	32·0	1·23
0·75	9·5	4·65	14·7	1·55
1·0	8·55	4·4	13·6	1·59
2·0	8·0	4·1	13·8	1·73
4·0	8·0	4·1	13·9	1·74
24·0	8·0	4·1	13·9	1·74

Gelatin concentration: 3·35 gm. per litre, in 0·5 molar saline, *p*H 6·8

These results show that the gelatin fraction contributed only two-thirds of the original 90° scatter, and gave unit dissymmetry of scatter, within experimental error. From the 90°-scatter due to gelatin a value of 22,000 was deduced for M_w.

In low-angle studies the extra accuracy available through the trypsin digestion technique is incompletely realized unless the solutions are clarified as effectively as possible. On the other hand, in the determination of molecular weight by the 90°-scatter method, where the suspended impurities contribute a smaller proportion of the total scatter, poor clarification may be adequate. For example, a 0·5 *M* saline neutral solution of another gelatin fraction was divided into two parts, and one part was filtered as in the above experiment whereas the other was filtered, under gravity, through a coarser sintered glass disk only. The following results were obtained:

	Type of filter 2	'5 on 3'
Molecular weight gelatin	119,000	115,000
Percentage original 90°-scatter due to gelatin	64	98

In principle, the method is applicable to many macromolecular systems, and may be found to be particularly useful for aqueous solutions, many of which are more difficult to clarify than non-aqueous solutions. The successful application of the technique rests principally upon selective breakdown of the macromolecules under investigation, and it is in this connexion that enzymic attack can be so valuable. It is also necessary that the mode of degradation should interfere as little as possible with the scattering from the solution, and that the impurities should not settle out of solution during the experiment. As the above experiments confirm, the gelatin/trypsin system meets these requirements.

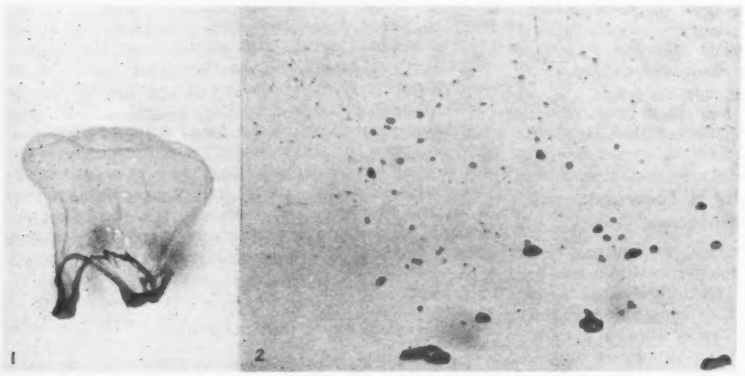
G. Stainsby
British Gelatine and Glue Research Association,
2a Dalmeny Avenue,
Holloway, London, N.7.
Nov. 11.

Shattering of Large Drops

The purpose of this communication is to present some experimental results obtained during a laboratory investigation of the mechanism of the break-up of drops. Results of previous workers indicate that drop deformation and turbulent air flow are major factors in the break-up of drops suspended in the air stream of vertical wind tunnels. Shattering break-ups have been observed for drops 5–9 mm. in diameter as a result of sudden changes in the velocity of the wind stream, or as a result of collisions between drops[1]. The fragments from the disintegrations of one hundred parent drops between 9 and 12 mm. in diameter have been collected and a size distribution determined[2]. No account of the actual mechanism

of break has come to our notice, although factors responsible for the deformation of drops between 5 and 7 mm. in diameter have been evaluated[3].

We now report a phenomenon associated with the shattering of large drops that apparently has escaped the attention of previous workers in the field. Reasonably well-formed drops, 10–25 mm. in diameter, were allowed to fall through stagnant air and the resulting break-ups observed. Most drops larger than 10 mm. in diameter and all drops larger than 12 mm. in diameter were shattered with considerable violence after a limiting velocity had been reached. High-speed photographic techniques were employed in the study of the actual break-ups, and hundreds of photographs were obtained showing their different phases.



(1) Inflated drop in which the canopy has been torn by aerodynamic forces. (2) Fragments from the break-up of a drop 15 mm. in diameter

Photographic evidence indicates that deviation from sphericity increases with increasing velocity of the drop as it falls through the air. Smaller drops assume a reasonably stable shape at terminal velocity; but larger drops are deformed to such a degree before the terminal velocity is reached that a critical value for the ratio of the minor to the major axis is attained. When this ratio is reached, the centre of the flattened drop suddenly bulges upward and the drop opens in somewhat the same manner of a parachute. Aerodynamic forces immediately rupture the canopy of the inflated drop, which disintegrates into a shower of smaller droplets. From the time the first bulge appears on the upper surface of the parent drop until the break-up is complete, less than one-fifteenth of a second elapses. Fig. 1 shows a typical drop in the stage of disintegration in which the canopy has just been torn by aerodynamic forces. The size distribution of fragments to be expected from the break-up of a 15-mm. drop is indicated in Fig. 2.

We wish to thank the Nova Scotia Research Foundation for the support given this project. Further details of the work and techniques of large-drop formation will be published elsewhere.

R. H. Magarvey
B. W. Taylor

Department of Physics,
Acadia University,
Wolfville, Nova Scotia,
Canada.

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Solvent Extraction of Polonium from Nitric Acid Solutions

The usual valency of polonium is 4, as was established by tracer-scale investigations[1] and by recent studies[2] with milligram amounts of the element. It has also been suggested[3], from electrochemical deposition experiments and co-precipitation studies, that hydrazine, hydroxylamine, sulphur dioxide, oxalic acid and hydrogen peroxide can, in certain conditions, reduce tracer-amounts of polonium to a lower valency state, the reduction occurring readily.

Recent investigations[2] with weighable quantities of material have shown that quadrivalent polonium is reduced, in halogen acid solution, by sulphur dioxide and hydrazine to a bivalent state, with some evidence for an intermediate trivalent state in the case of the chlorides. It was found that hydroxylamine and oxalic acid have no effect on solutions of polonium chlorides, and that hydrogen peroxide oxidizes macro-amounts of bivalent polonium to the quadrivalent state.

Investigating the extraction of trace amounts of polonium from nitric acid solutions by diethyl ether and other organic solvents we found an interesting property, probably related to a lower-valency state of this element.

Some microcuries of pure polonium, prepared by anodic electrodeposition[1], were dissolved in nitric acid with a molarity ranging from 1·75 to 8. Negligible extraction was found by shaking these solutions with the same volume of peroxide-free diethyl ether, in the absence of daylight. However, when ether containing peroxide was used, a part of the polonium passes into the organic phase. The polonium was found to be extracted by peroxide-free diethyl ether when some drops of hydrogen peroxide or some milligrams of hydrazine or hydroxylamine were previously added to the nitric acid solution; with oxalic acid no extraction was observed.

When sulphur dioxide was bubbled through concentrated nitric acid solutions of polonium visible decomposition was observed, and the polonium was not extracted from these solutions by peroxide-free ether. Extraction occurs when the nitric acid molarity is adjusted after previous reduction of polonium by sulphur dioxide in dilute nitric or hydrochloric acid. Fig. 1 illustrates the effect of increasing nitric acid molarity on the percentage of polonium extracted, for the various reducing agents used.

It can be seen from the graph that approximately the same percentage of polonium is extracted, at a given nitric acid molarity, by peroxide-containing ether and also by peroxide-free ether when to the aqueous phase hydrogen peroxide or sulphur dioxide is added. However, the results with sulphur dioxide are less reproducible at high nitric acid molarities, which is probably due to the oxidation of this reagent by nitric acid. The percentages of polonium extracted are approximately the same as those obtained in the extraction of uranyl nitrate from nitric acid solutions

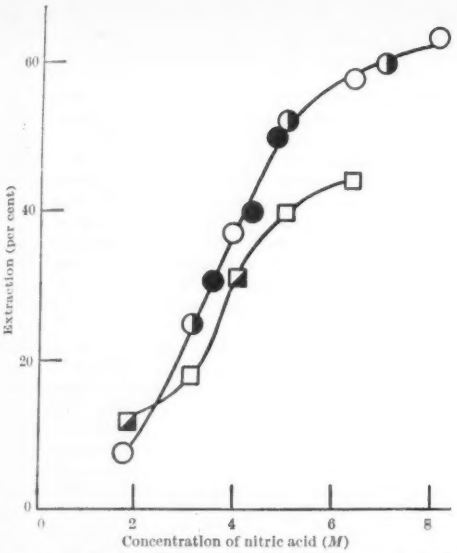

Fig. 1. ●, Sulphur dioxide; ◑, hydrogen peroxide; □, hydrazine; ◪, hydroxylamine; ○, organic peroxide

by diethyl ether; nearly 65 per cent of polonium is extracted from a solution in 8 *M* nitric acid by ether containing peroxide.

The same amount of polonium is extracted by peroxide-free ether when the nitric acid solution contains hydrazine or hydroxylamine; the percentages of extraction are lower than those obtained with ether containing peroxide or with the other reagents. Visible decomposition of the solution was observed at nitric acid concentrations greater than 7 *M*, and no extraction was possible from these solutions.

No extraction occurs if instead of these reducing agents a strong oxidant such as chromic acid is added to the nitric acid solution containing the radioelement. Complexing agents of polonium such as hydrochloric acid lower the distribution coefficient, and no salting-out effect was found by adding ammonium nitrate to the nitric acid solutions. Back-extraction was readily verified when the organic phase with the extracted polonium is shaken with water.

In the presence of the same reducing agents other organic solvents such as di*iso*propyl ether and *iso*amyl alcohol also extract polonium from concentrated nitric acid solutions, although to a smaller extent than diethyl ether. However, it was found that with *n*-amyl alcohol and methyl*iso*butyl ketone the extraction occurs even when no reagent is added to the nitric acid solution; but the presence of reducing agents in these solvents was verified. On the contrary, oxygen-free solvents such as carbon tetrachloride or chloroform fail to extract the radioelement in any conditions.

In agreement with the previous work on the tracer-scale, the solvent extraction behaviour of tracer-amounts of polonium suggests that hydrogen peroxide and hydroxylamine act as reducing agents in the conditions described. The reduction of trace-amounts of polonium by hydroxylamine has been reported before[2b] in acetic and sulphuric acid media, on warming the solutions. It is interesting to observe that for plutonium also the oxidation-reduction behaviour of trace amounts with hydrogen peroxide, in nitric acid solution and other media, differs from that with macro-concentrations of the element[4]. In the trace-experiments quadrivalent plutonium appears to be oxidized to quinquivalent plutonium or to sexavalent plutonium, whereas in the macro-experiments reduction to trivalent plutonium was observed.

It has been shown[5] that only a limited number of elements that have a marked tendency to form nitrate complexes are extracted in relatively high proportion from nitric acid solutions by diethyl ether. Investigating the anion-exchange behaviour of polonium in the presence of reducing agents, we have found evidence for negatively charged complexes in nitric acid media (unpublished results).

We are indebted to Prof. Fritz Feigl and to Dr. K. W. Bagnall for helpful discussions.

J. Danon
A. A. L. Zamith

Escola Nacional de Quimica,
Rio de Janeiro.
Nov. 19.

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Chromatographic and Spectroscopic Properties of Ellagic Acid, and its Occurrence in Dicotyledonous Plants

Chromatographic and spectrophotometric properties of ellagic acid have now been investigated in order to facilitate the identification of this acid in plant extracts and hydrolysates. In early studies, ellagic acid has not always been adequately characterized; but the present work has confirmed the occurrence of this substance in a wide range of dicotyledonous plants[1]. Ellagic acid has also been identified in *Terminalia arjuna*, *bellirica*, *citrina*, *pallida* and *travencoriensis* for the first time.

Table 1. R_F Values

Compounds	Ellagic acid	Flavellagic acid
Aqueous 40 per cent (v/v) formamide, *p*H 3·5	0·33	0·12
60 per cent formamide, *p*H 3·5	0·61	0·27

In order that paper chromatography may be used for the unequivocal identification of ellagic acid, solvent systems must be selected in which this substance has a reasonably high mobility. It has now been found that formamide – water mixture, buffered at *p*H 3·5 with formic acid, separates ellagic and flavellagic acids (Table 1). Ellagic acid has a high R_F value (0·70)[2] in benzyl alcohol–*tert.*-butanol–*iso*propanol–water (3 : 1 : 1 : 1) mixture containing 1·8 per cent formic acid, and this solvent system has also been found useful for chromatographic identification purposes.

A study of the absorption spectra of ellagic and flavellagic acids (Table 2) has now shown them to

Table 2. Absorption Spectra (Maxima, in mμ, followed by log ε) in β-Methoxyethanol

Ellagic acid	256 (4·53);	279 (4·63);	357 (4·15)
Flavellagic acid	260 (4·58);	279 (4·51);	358 (4·14)

Table 3. Infra-Red Measurements (Bands in cm.$^{-1}$, followed by the Group Concerned) in 'Nujol' Mulls and Potassium Bromide Disks

Ellagic acid	Flavellagic acid	
1,712	1,712	; carboxyl stretching vibration
1,600, 1,580, 1,518	1,600, 1,580, 1,518	; aromatic bands
3,200	3,200	; H-bonded hydroxyl
3,570, 3,485	3,445	; free hydroxyl

belong to the type characteristic for compounds in which the phenolic hydroxyls are conjugated through the aromatic nucleus with carbonyl functions. Infra-red measurements (Table 3) have now shown a fundamental carbon–oxygen stretching vibration at 1,712 cm.$^{-1}$, which is assigned to the lactonic carboxyls. The comparatively low frequency of the lactonic carboxyl band is due to the lack of strain in six-membered lactone rings[3], and also to the fact that the lactonic carboxyls are attached to aromatic rings. It is well known[4] that the frequency of carboxyl functions is less when measured in the solid state than in solution. Both substances have bands assignable to H-bonded and to free hydroxyl, the band at 3,445 and 3,485 cm.$^{-1}$ respectively in the two substances being too strong to be assigned to the overtone of a ketonic carbon–oxygen stretching vibration. All attempts to prepare ketonic derivatives of ellagic acid have failed. In the solid state and in neutral and acidic solution, ellagic acid behaves in agreement with the conventional configuration, and it lacks unusual ketonic properties.

Our electrometric titration of ellagic acid shows that dissolution in cold alkali is not accompanied by ring-fission, and this is of interest in connexion with the recent isolation[5] from alkaline medium of a quinonoid benzylation product, $C_{42}H_{30}O_8$, by a reaction clearly involving enolic-benzylation of the lactone carbonyls. In alkaline solution, ellagic acid reacts in this case in the tautomeric quinonoid form, previously suggested in an entirely different context by Perkin[6].

Resonance energy is associated with the condensed ring-structure for ellagic acid, and it is accordingly suggested that the correspondingly low redox potential explains the poor response which the substance gives with the ferric chloride – ferricyanide reagent for polyphenols.

Some aspects of ellagic acid chemistry are now being studied in these laboratories, and detailed results will in due course be communicated elsewhere.

I thank Dr. H. Phillips, director of the British Leather Manufacturers' Research Association, for his interest and encouragement, and the Council of the Association for permission to publish this communication. I am indebted to Mr. D. E. Bethell, British Rubber Producers' Research Association, for recording the infra-red spectra.

D. E. Hathway

British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey. Dec. 13.

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Discoloration of Muscle Preparations from Codling (*Gadus callarius*) by Degradation Products of l-Methylhistidine

Brown discolorations of foodstuffs, resulting from Maillard-type reactions between amino-compounds and sugars, have been known for many years. Recently, it has been established that in the whole muscle of fish and the separated muscle extractives, reactions between amino-compounds and ribose may take place very readily: the free glucose in the muscle is less reactive[1,2]. However, evidence has been accumulating in this laboratory that such reactions may not contribute all the discoloration found in the muscle of codling under certain processing conditions.

Freeze-dried preparations of muscle extractives showed relative humidity/'browning' relations atypical of Maillard reactions[3], and considerable quantities of free sugars have been detected in badly 'browned' samples of stored vacuum contact-plate-dried muscle kindly given by Mr. E. J. Rolfe. High sugar values have also been found in 'browned' samples of freeze-dried muscle prepared by Dr. A. C. Jason, Dr. R. M. Love and me at this Station and afterwards stored over phosphorus pentoxide at room temperatures ($\sim 15°$ C.) in daylight (conditions which would largely eliminate Maillard reactions). In darkness, little or no 'browning' was observed under these zero-humidity conditions. Maillard-reactive free amino-nitrogen was in very large excess over sugar in all these preparations[3,4].

In investigations into the enzymic hydrolysis of anserine (β-alanyl-1-methylhistidine) in the muscle of codling, it was reported that synthetic *dl*-1-methylhistidine was unstable and developed discoloration in light[3]. As the natural amino-acid is liberated rapidly in the muscle after death (to some 60–80 mgm. after 8–10 days storage in ice at an ambient temperature of 2° C.[4]), it was thought that 1-methylhistidine degradation could contribute appreciably to any discoloration taking place during processing and storage of dehydrated fillets. For the present study, *dl*-1-methylhistidine has been prepared by the hydrolysis of anserine-containing fractions from pike (*Esox lucius*)[5] and fractionating the hydrolysate by displacement from 'Dowex 2 (OH)' resin columns with *N*/50 hydrochloric acid. The anhydrous amino-acid was repeatedly crystallized from 80 per cent ethanol.

The extractable free amino-acids and sugars of the muscle of 18–24 in. codling were removed from structural material by exhaustively dialysing homogenates against distilled water. Aliquots of extractive-free suspension, together with *dl*-1-methylhistidine at a concentration equivalent to 50 mgm. per 100 gm. wet weight original muscle, were freeze-dried over phosphorus pentoxide. They contained 0·3–0·4 per cent 'water' as estimated by 4-hr. heating to constant weight in a forced-draught oven at 105° C. Stored in desiccators over phosphorus pentoxide in daylight at 15° C., the preparations changed rapidly from white to yellow-brown at the surface. Controls with no 1-methylhistidine remained white, as did preparations containing the amino-acid if they were stored in darkness.

When freeze-dried suspensions containing 1-methylhistidine were equilibrated and stored at different relative humidities, it was found that, in preparations at high humidities (60–100 per cent relative humidity), a yellow-brown coloration appeared throughout:

this coloration did not occur in the absence of the amino-acid and was noticeable at relative humidities as low as 30 per cent. 'Browning' increased rapidly with temperature. During these experiments, controls with no added amino-acid have been checked chromatographically for the appearance of sugar from non-dialysable bound forms, and this has not been found. Under these conditions, it is possible that metallic ions bound to protein in a non-dialysable manner could be available to catalyse the degradation.

In relation to this work, it is of interest that 4 (5)-methylimidazole has been isolated from mixtures from Maillard-type browning reactions between glucose and ammonia[6] and glucose and glycine[7], so that there is evidence that simple imidazole compounds may lie on one of the pathways of such reactions. In physico-chemical studies on histidine, Lewin[8] has demonstrated degradations leading to the formation of yellow coloration in solution, and that glucose may inhibit this action under certain conditions.

The present communication indicates that simple compounds of imidazole type may initiate a non-enzymic discoloration of foodstuffs in the effective absence of sugar. It is not suggested that, in the presence of sugar and free amino-compounds under Maillard-reactive conditions, it is likely to be a major factor in 'browning'. Admixture of *dl*-1-methylhistidine and *d*-ribose under such conditions gave a dark-brown coloration considerably in excess of the yellow-brown obtainable with the amino-acid alone.

The chromatographic separations of anserine and *dl*-1-methylhistidine were carried out in part by Mr. J. Murray. The work described in this communication is part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

N. R. Jones

Torry Research Station,
Aberdeen. Nov. 29.

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Experimental Allergic Encephalomyelitis produced by Tubercle Bacillus Residues

It has been known for some time[1] that mixtures of acid-fast bacilli and homologous brain in water-in-oil emulsions produce allergic encephalomyelitis when injected parenterally into animals. A knowledge of the chemical composition of the substances responsible for producing this reaction is important, because of the light it might throw on processes occurring in some human and animal demyelinating diseases. Much attention has been devoted to the chemistry of the brain factor[2]; but relatively little is known concerning the bacillary factor. The latter was considered by Allegranza and Rovescalli[3] to be a high molecular-weight complex consisting largely of protein with the lipopolysaccharide acting synergistically. Working independently and along similar lines, we reported[4] that residues left after fat extraction of human tubercle bacilli retained encephalitogenic activity, whereas the material extracted was inactive; the activity was relatively resistant to acid, alkali or proteolytic enzymes, and was present only in the insoluble residues. It has now been found that, when tubercle bacilli are treated serially with these reagents, the insoluble residue is still active.

The starting material, obtained from Glaxo Laboratories, Ltd., was heat-killed human tubercle bacilli, which had been extracted with acetone and *iso*propyl ether[4]. A sample (10 gm.) was treated successively with *N*/2 potassium hydroxide for 48 hr. at 0–4°, *N* hydrochloric acid for 24 hr. at room temperature, pepsin (B.D.H., 200 mgm.) in *N*/10 hydrochloric acid for 24 hr. at 37° (two digestions), trypsin (B.D.H., 200 mgm.) in *M*/10 sodium bicarbonate for 24 hr. at 37° (two digestions). The dried residue, which after these treatments weighed 2·8 gm., was then extracted (Soxhlet) for four days with each of the following solvents to remove any free lipid: *n*-butanol, benzene and finally chloroform–methanol (2 : 1, v/v). Most of the lipid was extracted by the first solvent, and by the end of each four-day period no further material was being extracted. The resulting residue, on drying, weighed 1·9 gm. and was a pale yellow powder, no longer acid-fast by the Ziehl–Neelsen staining technique.

The residue was tested, as described by Colover[4]; it was incorporated (0·5 mgm./ml.) in an emulsion containing 'Bayol F' (Esso Standard Oil Co., N.J.), 'Falba' (Pfaltz and Bauer, Inc., N.Y.) and homologous brain suspension and the mixture injected intramuscularly into a group of six guinea pigs. Four injections of 1 ml. each were given at weekly intervals to each animal. On the thirty-first day the three survivors were killed. One animal was killed on the twenty-eighth day because it had become moribund; two others died a few days before the thirty-first day and had become paraplegic. On histological examination, the three animals which had shown clinical signs and one which had not were found to have the typical lesions of experimental allergic encephalomyelitis, as illustrated in Fig. 1. Histologically, two showed some evidence of perivascular demyelination in addition to the characteristic cellular reactions, but the amount of demyelination was somewhat less than that produced by the original starting material.

The analysis of the residue is given in Table 1. The percentage figures are based on dry weight. Carbohydrate was determined in the supernatant

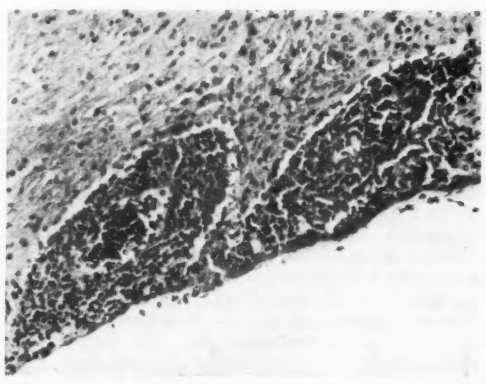

Fig. 1. Cross-section of guinea pig brain showing intense inflammatory-cell infiltration in the neighbourhood of two sub-ependymal venules (hæmatoxylin and eosin. × 210)

Table 1. Analysis of Active Residue

Nitrogen	11·9 per cent
Hexosamine (ref. 5)	1·0 ,, ,,
Carbohydrate (as galactose-mannose) (ref. 6)	12·7 ,, ,,
Mycolic acid	9·8 ,, ,,
Amino-acids (liberated by 6 *N* hydrochloric acid)	Alanine (strong), glutamic acid (strong), diaminopimelic acid (moderate). Others, relatively weak or moderate
Sugars (liberated by *N* sulphuric acid) (ref. 7)	Glucose, galactose (both weak)

after hydrolysis with *N* sulphuric acid. Mycolic acid was determined by isolation following hydrolysis of a weighed sample with 6 *N* hydrochloric acid at 105–110°. The black residue was extracted with hot *n*-butanol. On cooling, the precipitate was collected and weighed. (A further small quantity was obtained from the mother liquor.) The crude substance was acid-fast; its melting point was 53–57°, undepressed by admixture with an authentic sample of mycolic acid supplied by Dr. N. Polgar. The equivalent was about 1,100 (alkali titration) and it contained C, 79·6; H, 12·5 per cent (α-mycolic acid, $C_{88}H_{176}O_4$ requires C, 81·4; H, 13·7 per cent and equivalent, 1,296). The total lipid, which was extracted by chloroform from another hydrolysed sample, was close in amount to the mycolic acid content, and did not appear to contain any other fatty acids in appreciable quantity.

Hydrolysed samples of the residue were examined for amino-acids and sugars by paper chromatography and paper electrophoresis[6]. The amounts of sugars observed were much smaller than expected from the apparent carbohydrate figure in Table 1. Because of this and also because much of the original carbohydrate of the starting material would have been removed by the various treatments, this figure is probably too high.

Since the tubercle lipopolysaccharide, 'wax D'[8], contains similar components to those in the active residue, it was decided to test this substance and also a sample of methyl mycolate, strain Marmorek (melting point 39°) (both supplied by Dr. E. Lederer), for activity as described above and at a dosage of 0·5 mgm./ml. Both substances were found to be inactive. On the other hand, Waksman and Adams[9] found that lipopolysaccharide and wax from tubercle bacilli were active in the production of experimental allergic encephalomyelitis in rabbits. However, these substances were much less active than the intact bacilli, and may not have been entirely free from tuberculoprotein. Several attempts by ourselves and others[3] with wax preparations have failed to produce positive results in guinea pigs. So far as our observations are concerned, the active principle in the tubercle bacillus is a relatively stable and insoluble substance. Although no attempt has yet been made to assess quantitatively the amount of activity of the residue as compared with that of the starting material[4], it is significant that even after a loss of more than 80 per cent as a result of the various treatments, the residue was still active at the same level (0·5 mgm./ml.). This residue is largely protein in character, with glutamic acid and alanine as predominant amino-acids. It would also appear that the mycolic acid present is chemically bound to protein, which would accord with its insolubility and resistance to chemical attack. It is conceivable that this type of substance, which may also contain some polysaccharide, is responsible for the encephalitogenic activity.

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J. Colover
R. Consden

Department of Pathology and
Special Unit for Juvenile Rheumatism,
Canadian Red Cross Hospital,
Maidenhead, Berks, England.

Dec. 17.

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Effect of Vitamin B_{12} Deficiency on Liver Dehydrogenase Activity in Rats

Weanling rats born of mothers maintained on a diet deficient in vitamin B_{12} during pregnancy were fed on a vitamin B_{12}-free ration for twelve weeks and their liver dehydrogenase levels were compared with those of similar animals receiving 2-μgm. supplements of vitamin B_{12} daily. The basal diet had the composition: whole soya bean flour, 25; groundnut cake flour, 14; sesame cake flour, 14; wheat flour, 14; rice flour, 14; Bengal gram flour, 14; vitaminized starch, 2 (containing adequate quantities of all B-complex vitamins except vitamin B_{12}); shark liver oil, 2; Osborne and Mendel salt mixture, 1. At the end of the experiment, the animals were killed and the excised livers freed of blood clots and immediately chilled and used for measurement of dehydrogenase activities. Liver homogenates prepared in ice-cold *M*/15 phosphate buffer of *p*H 7·2 were used for the measurement of lactic, glutamic, succinic, butyric and choline dehydrogenase activities, according to the method described by Sreenivasa Murthy and Swaminathan[1], using tetrazolium bromide as the hydrogen acceptor. Portions of the liver tissue were used for nitrogen estimation by the Kjeldahl method. The vitamin B_{12} content of the liver was measured microbiologically using *L. leichmannii*-4797 as the test organism.

In a second series of experiments, the effect of vitamin B_{12} injection to deficient rats on the regeneration of liver dehydrogenases was studied. The levels of dehydrogenases in these animals were compared with those found in positive control groups that had been receiving the vitamin supplements since the beginning of the experiment.

The results for dehydrogenase-levels of animals on the diet deficient in vitamin B_{12} and control animals are presented in Table 1. They show a significant difference in weight between the vitamin B_{12}-deficient and control animals, although there was no difference between the two groups with respect to the weight of the liver or the nitrogen content of the liver. The general level of various dehydrogenases in the liver is, however, reduced. The differences in enzyme activity between deficient and control groups are statistically significant. The fact that the pattern

Table 1

Diet	Average gain in weight (gm.)	Average liver weight (gm.)	mgm. Nitrogen/gm. of liver	Average B_{12} (mμgm./gm. liver)	Enzyme activities (μgm. of indicator reduced/gm. of liver tissue)				
					Lactic	Glutamic	Succinic	Butyric	Choline
1 (deficient)	108·0 (9)	7·4 (9)	31·6 (8)	62·4 (7)	757·1 (7)	680·6 (9)	1,621·2 (9)	354·4 (9)	524·4 (9)
2 (control)	131·1 (9)	7·5 (9)	32·3 (8)	160·0 (7)	1,014·3 (7)	1,001·1 (9)	1,978·7 (9)	616·7 (9)	815·7 (8)
	± 4·24* 8 deg. of freedom	± 0·19 8 deg. of freedom	± 0·43 7 deg. of freedom	± 7·6 6 deg. of freedom	± 75·5 6 deg. of freedom	± 61·6 8 deg. of freedom	± 24·2 8 deg. of freedom	± 45·8 8 deg. of freedom	± 162·2 7 deg. of freedom

* Standard error of the mean. Figures in parenthesis represent the number of animals.

of change in the deficient animals is always a lowering in all the enzymes studied would indicate that the action of vitamin B_{12} is probably a general one of promoting the synthesis of enzymic protein rather than as a coenzyme factor for the enzymes studied. This is substantiated by *in vitro* studies, where the addition of vitamin B_{12} to the liver homogenates failed to raise the enzyme activities to the same level as those of the vitamin B_{12}-fed controls.

The results of studies on the rate of enzyme regeneration when vitamin B_{12} was injected into deficient animals as obtained in the second series of experiments have been somewhat inconclusive and have not been reported here. A statistical interpretation of the data was not possible owing to the large individual variations and the small number of animals used (four for each group). These experiments are therefore being repeated on a larger number of vitamin B_{12}-deficient animals.

We are indebted to Dr. V. Subrahmanyan, director of this Institute, for his interest in this investigation.

V. Sreenivasa Murthy
H. S. R. Desikachar
M. Swaminathan

Central Food Technological Research Institute,
Mysore.
Nov. 29.

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Fæcal Micro-organisms of Parabiotic Rats

Surgical techniques for the production of artificial Siamese twins ('parabiotics') are well established for small laboratory animals, and, in skilled hands, provide an elegant method for study of hormone circulation and other problems involving humoral transmission. There is some doubt as to whether capillary anastomosis or the lymphatic system is the primary mode of transfer from one twin to the other; but, in either case, it would seem that parabiotic animals are excellent material for nutritional research. In this connexion, it may be of interest to record that a pair of rats joined in this way since shortly after weaning were among a number of animals studied during a preliminary investigation of the influence of age and diet on intestinal micro-organisms.

The animals, both females, were just under eighteen months old (510 days). Shortly after weaning, they had been joined by the method of Bunster and Meyer[1] and formed part of an extensive programme of work with parabiotics of different ages being carried out at Cornell University by Prof. C. M. McCay and Dr. F. Pope[2]. The rats were receiving the same diet ('stock' + 10 per cent cooked egg) and their management was, of course, identical. It might be expected, therefore, that the various micro-organisms of their alimentary tract would be present in approximately equivalent numbers—assuming diet and intestinal environment to have some influence.

Errors in this type of work are known to be enormous; but the results of 'presumptive' counts from fæcal suspensions made on several days with each of the two rats were fairly consistent, and there was a relatively constant ratio between the numbers of the various organisms from one twin and those from the other, that is, the fæcal flora of the two halves was different. The individuality of each rat was therefore evident.

A pair of rats of comparable age (13 and 14 months), and on a comparable diet, were examined by the same method some time later (in Britain) and roughly the same degree of individuality as reflected in fæcal flora was found. These figures and those from the Cornell parabiotics are shown in Table 1.

Table 1. Number of Organisms per gm. of Fresh Fæces

		General numbers	Lactobacilli	Enterococci	Coliform organisms
I. *Parabiotics at Cornell*					
1	*L*	160,000 m.	875·0 m.	500	< 1 m.
	R	90,000 m.	346·5 m.	2,500	< 1 m.
2	*L*	14,000 m.	1,170·0 m.	1,700	35,000
	R	3,000 m.	1,515·0 m.	60,000	3,500
3	*L*	8,000 m.	1,610·0 m.	11,000	80,000
	R	3,500 m.	285·0 m.	> 180,000	2,500
4	*L*	3,000 m.	220·0 m.	> 160,000	35,000
	R	5,000 m.	840·0 m.	> 180,000	2,500
5	*L*	5,000 m.	1,120·0 m.	130,000	50,000
	R	1,300 m.	410·0 m.	900,000	250
II. *Separate individuals at Queen Elizabeth College*					
1	*A*	1,700 m.	1,950 m.	450,000	8·0 m
	B	2,500 m.	5,450 m.	80,000	1·7 m.
2	*A*	350 m.	805 m.	30,000	8·0 m.
	B	800 m.	2,325 m.	50,000	0·25 m.
3	*A*	1,700 m.	420 m.	35,000	20,000
	B	250 m.	600 m.	50,000	110,000
4	*A*	500 m.	1,110 m.	11,000	1·3 m.
	B	1,300 m.	2,525 m.	25,000	0·5 m.
5	*A*	350 m.	303 m.	8,000	170,000
	B	2,500 m.	2,335 m.	30,000	< 20,000

m, million; *L*, left; *R*, right.

General numbers. Determined by the most probable number method in the reinforced *Clostridium* medium of Hirsch and Grinsted (ref. 3) incubated at 37° C. for 1 week. *Lactobacilli.* Plate count (double plates) on the medium of Rogosa *et al.* (ref. 4) incubated at 37° C. for one week. *Enterococci.* Determined by M.P.N. method in Hajna and Perry's (ref. 5) S.F. medium incubated at 45° C. for 48 hr. *Coliform organisms.* Determined by M.P.N. method in ordinary MacConkey broth incubated at 37° C. for 48 hr.

This work was largely exploratory. Extension of the types counted and refinement of method might have yielded more information, yet it is probably fair to conclude that parabiotic rats may be closely linked but show as much 'between animal' variation in their fæcal organisms as comparable separate animals.

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Helen R. White

Department of Bacteriology,
Queen Elizabeth College
(University of London).

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Growth of Bovine Amniotic Ectoderm as a Cell Monolayer on Glass and its use as a System for Virus Multiplication

It has been found in this laboratory that monolayer cultures of cells on glass can be prepared successfully from bovine amniotic membranes. Such cultures have proved to be suitable for differential growth-curve experiments with the virus of foot-and-mouth disease in which frequent changing of the medium is necessary. The yields of virus obtained were essentially similar to those obtained with cell suspensions or monolayer cultures derived from adult bovine tongue tissue. This success, and that of Zitser *et al.*[1] with similar monolayer cell cultures from human amnion in growing the virus of poliomyelitis, suggest the more extended use of fœtal membranes for the study of mammalian viruses, and particularly those with a very restricted host or tissue susceptibility.

Pregnant bovine uteri are obtained from the abattoir, if possible on the day of slaughter. The uterus is first washed with a 1 : 100 dilution of a quaternary ammonium compound, 'Deciquat' (The British Hydrological Corporation), and then with sterile physiological saline; the uterus and fœtal membranes are then incised with aseptic precautions. When the amniotic fluid has been collected for use as a culture medium[2], the fœtus is removed and the amnion stripped from the chorio-allantois. On removal of the amnion, it is placed intact in a flask containing either a solution of trypsin, if to be used at once, or amniotic fluid if to be stored for future use. Storage at 4° C. in amniotic fluid, with subsequent satisfactory growth of cells, has been carried out for periods up to nine days.

For the preparation of cell suspensions, a 0·25 per cent solution of trypsin ('Difco' 1 : 250) in a calcium- and magnesium-free modified Tyrode's solution[3] is employed, with incubation for 1–3 hr. at 37° C. During incubation the flask is agitated to assist the separation of cells and, on completion, an excess of the modified Tyrode's solution is added to the flask. The amnion is removed to another flask containing sterile modified Tyrode's solution for washing to ensure removal of all separated cells. The cell suspension from the first flask plus the washing fluid from the second flask are pooled and allowed partially to sediment, or it is filtered through stainless steel mesh to remove the amniotic pustules and other large fragments of tissue. The decanted or filtered cell suspension is then centrifuged at 1,000 rev./min. for 2 min. and the cell deposit resuspended in amniotic fluid plus 10 per cent ox serum to give a concentration of approximately 10^6 cells per ml. It is unnecessary to wash the cells to remove trypsin if ox serum is incorporated in the growth medium.

An amnion from a fœtus of 10–30 cm. head-rump length yields approximately 100 ml. of a suspension containing 10^6 cells per ml., that is, sufficient to inoculate ten 80-mm. Carrel flasks. These cell suspensions, even after prolonged exposure to trypsin, contain a large number of cell clusters which do not readily break down further. For purposes of cell counting, clumps of ten or more cells are counted as ten, and a suspension containing nominally 10^6 cells per ml. usually includes approximately 3×10^4 such clumps per ml. On inoculation into a flask, these cell clumps become attached to the glass and within 48 hr. an intact sheet of cells develops between them. After a further two or three days incubation at 37° C., the cell clusters become detached from the glass, leaving behind a very regular, intact monolayer sheet of cells. The paucity of mitotic cells in stained preparations, coupled with the rapidity with which the monolayer is formed, suggest that the bulk of the cell sheet is produced by migration of cells from the cell clusters rather than by cell division. If a more dilute seed inoculum is used, an extensive cell sheet develops within 48 hr. around the cell clusters, but it usually takes many more days for these discrete growth areas to become confluent and the resulting cell sheet is invariably very irregular and fenestrated, with a wide variation in cell morphology and size.

A monolayer produced from a heavy seed inoculum consists of an intact sheet of polygonal ectodermal cells, with an optically clear, very transparent cytoplasm. In living cultures nuclei can be seen, but the cell borders can be distinguished only faintly. In methanol-fixed preparations stained by May-Grünwald–Giemsa, only the nuclei could be identified against a homogeneous, palely stained background of cytoplasm.

By a direct count of nuclei per microscopic field of known area, total values of about $2{\cdot}5 \times 10^6$ cells are obtained for mature cell sheets in 80-mm. Carrel flasks.

Satisfactory growth of cells occurs when amniotic fluid is used alone, but the cell sheets have remained intact for a longer period if bovine serum is added to a concentration of 10 per cent. No advantage was apparent following the addition of bovine embryo extract. Antibiotics are added to the amniotic fluid at the time of collection (200 units of penicillin and 200 μgm. of streptomycin per ml.).

Amniotic membranes from fœtuses of 10-cm. head-rump length to nearly full term have been used with no apparent difference in rate of growth or susceptibility to infection by foot-and-mouth disease virus. In general, because the amniotic fluid from older fœtuses is not suitable as a culture medium, only fœtuses of 10–30-cm. head-rump length are used. On several occasions, fœtuses have been successfully employed following storage *in utero* overnight at 4° C.

Following inoculation of excess virus to cells, amnion cultures have usually shown cytopathogenic changes by 24 hr., progressing to complete degeneration by 48 hr. Occasionally, however, similar cultures have continued to release virus at a fairly constant rate for at least 60 hr. before showing evidence of cytopathogenic change. The irregularity of the time of appearance of cytopathogenic changes, together with the fact that mature cultures, even when stained with neutral red, are almost invisible to the naked eye, suggest that bovine amnion monolayers would not be particularly suitable for the titration of the virus of foot-and-mouth disease using Dulbecco's

plaque counting method[4], recently shown in this Institute by Sellers[5] to be possible with the virus of foot-and-mouth disease using monolayers of pig kidney cells.

Although infections with recognized pathogenic agents such as *Rickettsia burneti*, *Brucella abortus*, *Vibrio foetus*, etc., could occur following the use of amniotic membrane or amniotic fluid from a naturally infected fœtus, no evidence of such infection has been observed in this series of cultures prepared from more than twenty-five bovine fœtuses.

T. W. F. Pay

Research Institute
(Animal Virus Diseases),
Pirbright, Surrey.
Jan. 13.

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Isolation of β-Dihydroequilin and α-Dihydroequilenin from the Urine of Pregnant Mares

In 1937, Hirschmann and Wintersteiner[1] reported the isolation of 17-dihydroequilenin from the urine of pregnant mares and expressed surprise that no evidence of the presence of dihydroequilin was obtained. (The nomenclature used here is that employed by Carol and his co-workers[2,3,4,6].) Afterwards, the presence of β-dihydroequilin was detected in material derived from pregnant mares' urine by the dioxane hydrolysis procedure of Grant and Beall[2], but isolation was not effected[3].

We now wish to report the isolation of large quantities of pure β-dihydroequilin from two different concentrates of conjugated œstrogens prepared from pregnant mares' urine collected respectively at mid-pregnancy (approximately the sixth month of pregnancy) and at late pregnancy (approximately the ninth month of pregnancy). It was found that in both instances the proportion of β-dihydroequilin present exceeded the proportion of β-œstradiol. No α-dihydroequilin was found in either concentrate.

The findings of Hirschmann and Wintersteiner[1] were confirmed by the isolation of large amounts of β-dihydroequilenin from both concentrates, but in addition to this α-dihydroequilenin was also obtained. The latter appears to be present in such small proportion that it cannot be considered a major constituent of the naturally occurring œstrogens in pregnant mares' urine.

The concentrates of conjugated œstrogens were prepared by solvent extraction of pregnant mares' urine. Predominantly non-ketonic material was isolated by counter-current distribution methods. This non-ketonic, conjugated material was hydrolysed by heating for 1 hr. at *p*H 1 on the water-bath, freed from ketonic material by a Girard separation, and a phenolic, non-ketonic fraction isolated by extraction into sodium hydroxide. This phenolic, non-ketonic fraction, which was a mixture of œstrogenic diols, was finally separated into its components by the chromatographic methods described by Carol, Haenni and Banes[4] employing sodium hydroxide on 'Celite' (manufactured by the Johns Manville Co.) as the immobile phase and benzene as the mobile phase.

A concentrate of mixed conjugated œstrogens, giving a response by the Kober procedure equivalent to 100 gm. of sodium œstrone sulphate, fractionated by the methods described above, gave a phenolic, non-ketonic fraction which yielded 3 gm. of crystalline β-dihydroequilin (melting point 205–206°), identical with the β-dihydroequilin prepared by Carol, Haenni and Banes[4] by reduction of equilin with aluminium *iso*propoxide, and 1 gm. of β-dihydroequilenin (melting point 216–217°), identical with the material originally isolated by Hirschmann and Wintersteiner[1]; further quantities of β-dihydroequilin could also be isolated from various other side-fractions. Products were characterized by infra-red examination, preparation of derivatives and by analysis.

Throughout laboratory operations care was taken to avoid prolonged exposure of material to strongly acidic conditions. When this precaution was not taken, compound 3 of Hirschmann and Wintersteiner[1] was isolated in addition to β-dihydroequilenin and β-dihydroequilin and was presumably formed by isomerization of the latter in accordance with the findings of Banes, Carol and Haenni[5].

We shall publish this work in greater detail elsewhere.

W. L. Glen
R. Barber
H. M. McConkey
G. A. Grant

Research Laboratories,
Ayerst, McKenna and Harrison, Ltd.,
Montreal. Dec. 8.

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Mating Reaction in Yeast

A preliminary study has been made of the mating mechanism of haploid cells of *Saccharomyces cerevisiae*. Three haploid pairs were used: one pair from Dr. C. C. Lindegren and the others derived from two strains of baker's yeast (Lindegren's α = plus; a = minus mating type in Fowell's nomenclature).

Lindegren's discovery[1] that stable haploid clones of two mating types could be derived from the spores of certain strains of baker's yeast made it possible to investigate Winge's suggestion[2] that conjugation is hormone-controlled. When haploid cultures of opposite (plus and minus) mating types are mixed, or cells are paired on an agar film, the cells may put out hyphal ('copulatory') processes; and when these meet, fusion may occur and a dumb-bell-shaped zygote be formed, from which diploid cells may be budded. This sequence of events constitutes the mating reaction, and a cell which puts out a copulatory process may be said to show a mating response.

Experiments in which a plus cell was placed close to a minus cell and allowed to grow on a malt agar film in a moist chamber[3] showed that the mating reaction is probably hormone-controlled, since a

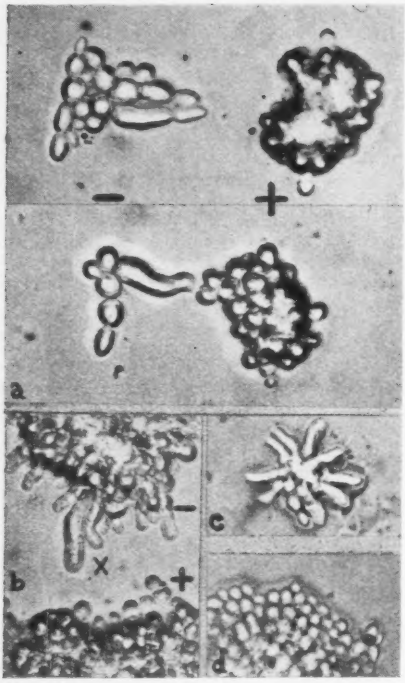

Fig. 1. (*a*) Two pairs of haploid cells, after incubation on a malt agar film; the cells of minus mating type show a mating response. × 430. (*b*) Parts of larger colonies, as (*a*). Both colonies were afterwards removed, and fresh minus cells were placed at point *X*. × 400. (*c*) Minus cells, after incubation on the agar at point *X*, show a mating response. × 400. (*d*) Fresh minus cells, showing normal morphology. × 400

mating response developed without contact between cells of opposite mating type; but it was found that only the minus cells put out copulatory processes (Fig. 1,*a*). In several experiments involving more than a hundred pairings of three pairs of haploids from different strains of yeast, plus cells never responded on a solid medium. The mating reaction occurred only after mutual interaction between a plus and a minus cell; but an agar surface from which sexually reacting cells had been removed could induce copulatory processes in minus cells added later (Fig. 1, *b*, *c*), but not in plus cells. However, on only one occasion was a mating reaction observed in a minus culture separated from a plus culture by a collodion membrane. In liquid medium, it should be noted, both plus and minus cells may develop copulatory processes.

The investigation is continuing, with particular attention to the isolation of chemical substances involved in the mating reaction. So far, an active culture filtrate has not been obtained from a mating mixture.

J. D. Levi*

Department of Botany,
Birkbeck College,
London, W.C.1.
Nov. 30.

* Present address: Distillers Co., Ltd., Research and Development Dept., Great Burgh, Epsom, Surrey.

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Viability and Developmental Capacity of Eggs from Immature Mice treated with Gonadotrophins

Sexually immature mammals induced to superovulate and mate following gonadotrophin treatment provide a convenient supply of fertilized mammalian eggs for experimental purposes. The time of their ovulation is known and is independent of diurnal regulation. The large number of eggs recoverable from a single superovulated female can be expected to contain less genetical and physiological variability than an equal number from several mature donors. Also, when egg recovery necessitates killing females, the economy of using immature animals is realized in greater egg productivity and in a shortened generation interval. It is important, therefore, to establish whether eggs from ovulations induced in immature females are of normal viability and developmental capacity. Previous evidence[1-3] on this problem is not decisive in that it lacks direct comparisons with spontaneously ovulated eggs, from adult females, developing in similar uterine environments. The present work was intended to meet these requirements.

Genetically tagged eggs from superovulated and mated immature mice[3] were transferred as 3½-day morulæ or blastocysts to the uteri of seventy-four adult recipients (each having borne one litter) in which ovulations and matings with fertile males were synchronous with those of the donors. A control series, run concurrently with the first, consisted of eighty-three similar transfers of eggs spontaneously ovulated by mature donors. Fifty-eight hosts from the first series and sixty-three from the control group became pregnant and were autopsied at 18½ days gestation. Fœtuses from transferred and native eggs were counted in each uterine horn, and body-weights to the nearest 0·01 gm. were taken after severing the umbilicus and removing embryonic membranes and surface fluid.

Donor and recipient matings were so arranged that fœtuses from transferred and native eggs, though distinguishable by presence or absence of eye pigmentation, were otherwise similar in genetic background. Donor and recipient females were from the same highly fertile albino stock. Males were from the inbred albino strain *A* and from a homozygous non-albino stock derived by repeated back-crosses to strain *A* with forced segregation at the albino locus. The genetic tags for transferred and native eggs were reversed for half the experimental and control transplants.

Viability of eggs from immature mice. A comparison of viability of eggs from immature and mature donors is made in Table 1 as percentage survival of transplanted blastocysts to living fœtuses at 18½ days gestation. Most transfer operations were bilateral, and percentage survival has therefore been computed within uterine horns rather than within hosts. (Transuterine migration of eggs[4,5] appears to be rare in the stocks used; only one case was observed among those 124 genetically tagged eggs which survived in forty-one uterine horns from unilateral transfers of 194 eggs.) Among hosts becoming pregnant, the incidence of horns with no transferred eggs surviving was greater than could be accounted for by chance occurrence; an estimation that whole inoculum loss of eggs occurs in 20–25 per cent of transplants is consistent with the data. Consequently, in Table 1 a separate column is given for percentage survival

Table 1. COMPARATIVE VIABILITY OF EGGS FROM IMMATURE AND MATURE MICE
Percentage survival to 18½-days gestation of blastocysts transplanted to mated adult recipients

Source of transplanted eggs	No. of eggs transplanted per horn	Survival in recipients becoming pregnant: No. horns receiving eggs	Total eggs transplanted	% survival to 18½ days	Survival in horns with one or more fœtuses from transplanted eggs: No. horns receiving eggs	Total eggs transplanted	% survival to 18½ days
Immature donors	4	53	212	35·85	35	140	54·29
Mature donors	4	40	160	38·75	30	120	51·67
Immature donors	2–6	88	377	40·58	63	272	56·25
Mature donors	2–6	86	322	48·76	68	255	61·57

in horns with one or more transferred eggs surviving. In all transplants (two to six blastocysts per horn), the comparative survival-rates of eggs from immature and mature donors show a divergence which may be a consequence of the difference in mean numbers of eggs per inoculum. Transplants of four eggs per horn were the most common, and the corresponding percentage survivals of eggs from immature and adult donors, of 35·85 and 38·75 per cent, respectively, are strong evidence for the normal viability of eggs from ovulations induced in immature mice.

Developmental capacity of eggs from immature mice. The developmental capacity of eggs transplanted from immature donors has been compared with that of spontaneously ovulated, untransplanted eggs developing in the same uterine environment, that is, eggs native to the adult recipients. Hosts to 3½-day eggs transplanted from adult donors provide a control for effect of transplantation on subsequent development. Comparisons were made within litters, and for each sex, of differences between mean weights of 18½-day fœtuses from transferred and native eggs. From these within-litter differences, weighted according to relative numbers of fœtuses, calculations were made of the best estimates of mean differences in weight and their standard errors (Table 2). Neither the mean difference in weight between fœtuses derived from eggs of immature and mature females, nor that between fœtuses from transplanted and untransplanted eggs of mature females, varied significantly from zero. On the basis of the overall estimate of mean weight difference, $-0{\cdot}017 \pm 0{\cdot}011$ gm., if a retarding effect of transplantation on embryonic growth exists, it is most unlikely to exceed 0·04 gm. ($P = 0{\cdot}05$) or 3 per cent of the mean weight of native embryos, 1·23 gm. It was concluded, first, that transplantation of 3½-day mouse eggs does not appreciably affect their subsequent embryonic growth in a host uterus of corresponding gestational stage and, secondly, that the developmental (growth) capacity of eggs from immature mice treated with gonadotrophins closely approximates that of eggs from spontaneous ovulations in adult mice.

Table 2. DEVELOPMENTAL CAPACITY OF 3½-DAY EGGS TRANSPLANTED FROM IMMATURE AND MATURE MICE
Comparisons within litters of weights of 18½-day fœtuses from transplanted eggs (immature and mature donors) and eggs native to the adult recipients

Source of transplanted eggs	Sex of fœtuses	No. litters for weight comparisons	No. fœtuses from trans. eggs (T)	No. native fœtuses (N)	Best estimate of mean difference in wt. (T–N) and stand. error (gm.)
Immature donors	♀	37	79	107	$-0{\cdot}005 \pm 0{\cdot}020$
	♂	39	74	139	$-0{\cdot}037 \pm 0{\cdot}020$
Mature donors	♀	35	69	119	$-0{\cdot}013 \pm 0{\cdot}029$
	♂	36	70	128	$-0{\cdot}011 \pm 0{\cdot}016$

I am grateful to Dr. R. A. Beatty for encouragement and supervision, to Prof. C. H. Waddington for facilities provided, and to Dr. M. N. Runner for instruction in transplantation techniques. This work, which will be published in detail elsewhere, is supported by a grant from the Jackson Memorial Laboratory, Bar Harbor, Maine, U.S.A.

ALLEN H. GATES

Institute of Animal Genetics,
University of Edinburgh,
King's Buildings,
West Mains Road,
Edinburgh 9.

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Reduction in Growth of Clover due to Applied Molybdenum

IN the course of co-operative investigations into problems of pasture establishment on coarse Taupo pumice, an observational minor-element trial was superimposed upon clover inoculation trials laid down by the Grasslands and Plant Disease Divisions, Department of Scientific and Industrial Research, N.Z. The soil was Kaiangaroa sandy and gravelly sand of *p*H 5·7 and low in available nutrients, derived from rhyolitic pumice deposited less than two thousand years ago.

Seed and serpentine superphosphate (3 cwt./acre) or, in one treatment in replicate *A*, a serpentine superphosphate/lime mixture containing 12 per cent lime, were 'roller drilled' in on March 19, 1954. 'Roller drilling' followed by brush harrowing covered the seed and fertilizer to a depth of about 1–1½ in. Minor elements (boron, sulphur, zinc, copper, vanadium, manganese, cobalt, singly and all combined and all crossed with sodium molybdate at 2½ oz./acre) were then watered, or in the case of sulphur, dusted on. Afterwards, 1 cwt. muriate of potash and 3 cwt. (spring 1954) and 1½ cwt. (autumn 1955) per acre of double superphosphate were applied.

Table 1. HERBAGE WET WEIGHT (LB. PER 100 FT. × 20 IN.; CUT MARCH 3, 1955

Treatments	Replicate *A* No Mo	Replicate *A* + Mo	Replicate *B* No Mo	Replicate *B* + Mo
Uninoculated + serp. super	18·1	7·0	16·2	8·9
Inoculated + ,, ,,	20·3	13·7	27·5	9·7
,, + lime/serp. super	18·7	20·3	—	—
Available soil Mo (Grigg) p.p.m.	0·07	0·18	0·07	0·34
Total soil Mo (p.p.m.)	—	— 0·51 —		—

Table 2. Plant Analyses

	P (%)	N (%)	S (%)	K (%)	Na (%)	Mg (%)	Ca (%)	Mn (p.p.m.)	Cu (p.p.m.)	Mo (p.p.m.)
White clover, no molybdenum	0·22	3·4	0·21	2·5	0·08	0·30	1·4	146	6·0	0·3
White clover, + molybdenum	0·23	3·5	0·22	2·7	0·07	0·30	1·3	148	6·9	1·0
Red clover, no molybdenum	0·13	2·2	0·14	1·5	0·03	0·35	1·5	155	6·2	0·36
Red clover, + molybdenum	0·14	2·6	0·15	1·9	0·03	0·34	1·4	189	8·7	0·5

No effects due to minor elements were seen on November 17, 1954. But on December 17, 1954, it was obvious that molybdenum was severely depressing growth on replicate *B* and by February 11, 1955, the same was true of replicate *A*, excepting where the lime/serpentine superphosphate mixture had been used. The clovers showed no abnormal visual symptoms. The effect continues at the time of writing. There have been no consistent effects due to other minor elements and no obvious interactions with molybdenum. Relevant measurements are given in Tables 1 and 2.

Both total and available soil molybdenum were relatively low, and plant molybdenum was normal to low. There appears to be no possibility of a direct toxic effect. Both inoculated and uninoculated clovers were depressed, more especially in replicate *B*, where the soil-available molybdenum, for some unknown reason, was higher. The results of analyses for plant constituents given in Table 2 show no gross abnormalities. When cut, the clovers, especially the red clover, had flowered and were stalky. This stage of growth at cutting may explain the rather low phosphorus, nitrogen and sulphur contents. The effect of a small amount of lime completely offset the depression due to molybdenum without greatly altering any plant constituent measured.

An attempt to reproduce this depression under glasshouse conditions has failed.

It is difficult to conceive of any mechanism which would account for this unusual happening. The cause probably lies within the general field of minor element interactions.

R. H. Jackman

Rukuhia Soil Research Station,
Hamilton, New Zealand.
Nov. 9.

A Small-scale Quality Test in Wheat Breeding

Dr. L. Zeleny, United States Department of Agriculture, Washington, D.C., has developed[1] and improved a lactic-acid wheat-flour sedimentation test for the grading of bulk wheat for quality. This test is in use at this Division as an aid to selection for high baking-quality wheats. In the preparation of the flour for the sedimentation test, wheat grain is passed through a 'C. and N. Junior' laboratory mill. By suitable pulleys the speed of the beaters is built up to approximately 14,000 rev./min. A metal screen fitted to the bottom of the mill has holes $\frac{1}{8}$ in. in diameter : eight holes to one inch. The ground wheat is sieved for $1\frac{1}{2}$ min. through cloth mesh 9×× using a 'Gallenkamp' laboratory shaker fitted with a time switch. The general procedure of the test follows that recommended by Dr. Zeleny (private communication).

The first application of the test was in the selection of good-quality single-plant progenies from a hybrid line. This line (derived from a single plant in F_2) had proved by F_{12} to be superior in yield and other agronomic characters to the standard New Zealand variety in large replicated trials in many districts ; but was inferior in baking quality. One thousand single-plant progenies from this line were grown in short rows of twenty-five plants, and the sedimentation test was applied to the bulked grain from each row. Only ten progenies with high sedimentation scores were found. In the following year the residue of seed from these ten progenies was sown at wide spacing, to provide sufficient grain for a baking test. The baking score of the test loaves, based on loaf volume and crumb texture, was better than that of the standard variety.

It has been considered necessary to establish the validity of the sedimentation test over a range of varieties and localities in New Zealand. In 1954, sedimentation test figures were correlated with the baking scores of sixteen samples of one variety drawn from replicated field trials in different districts ($r = 0{\cdot}89^{**}$). In 1955, samples were drawn from eight similar trials, each with seven varieties, in different localities. After the elimination, in the analysis, of differences due to varieties, high correlations were obtained over all localities between sedimentation test and two other tests of baking quality (Table 1).

Table 1

	Correlation coefficient
Sedimentation vs. baking score	0·88**
Sedimentation vs. total nitrogen (Kjeldahl)	0·85**
Total nitrogen vs. baking score	0·86**

It was found in the analysis of the set of trials, after the elimination of differences due to locality and error, that for varieties as a group, the correlation coefficient between the sedimentation test and baking score was only 0·08. Therefore it would appear that a calibration for individual varieties would be necessary before the general application of the sedimentation test. In a more extended series of trials covering further localities, the correlation coefficients for individual varieties ranged from 0·80 to 0·93. A graphical representation of the relationship between baking score and sedimentation test shows a set of variety regression lines which appear on preliminary evidence to be parallel.

The method has proved useful in the selection of single plants, grown at wide spacing, from hybrid bulks in the F_8 and F_9 generation. About 2 per cent of the material sown is selected on agronomic characters ; the individual plants are threshed, seventy-five grains are reserved for sowing, and the remainder are milled for the sedimentation test. 13 gm. of wheat, yielding 7·5 gm. of flour, are required for each test, but a less accurate test can be made on 8 gm. Grain from plants with sedimentation scores above the average for the particular bulk is sown for further observation. It is not desirable to set high limits for the selection of plants from each bulk : the test is accurate, but the relation between test score and baking score differs between varieties, and therefore between plants within a hybrid bulk. The value of small-scale quality tests is to allow the rejection, in the early stages of selection, of those plants or progenies which would have proved to be of poor baking quality. It has been found that, whereas the sedimentation test accentuates differences in quality at the higher end of the

scale, other small-scale tests in use are not sufficiently critical at this level.

The application of the sedimentation test to hybrids in advanced generations has been successful and the use of the test in the early generations of wheat crosses is under investigation. It may be possible to select for flour quality at the same time as for other agronomic characters.

L. G. Copp

Crop Research Division,
Department of Scientific and Industrial Research,
Private Bag,
Christchurch, New Zealand.
Nov. 22.

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Abnormal Hæmoglobins in the Kasai Province of the Belgian Congo

Hæmoglobin C was first detected among American Negroes, and figures for its incidence range between 1·4[1] and 3 per cent[2]. As the anomaly seemed virtually absent in the white race, it was reasonable to suppose that the gene responsible for it had been imported from Africa in the times of slave trade. This was soon confirmed by a survey of Edington and Lehmann[3], who found hæmoglobin C to be present in 12 per cent of 200 hospital out-patients in Accra (Gold Coast). Recently, individuals with this hæmoglobin have been reported from French North Africa[4]. It is also known to exist in Liberia and in French West Africa (Neel, J. V., personal communication).

In East Africa, surveys for abnormal hæmoglobins among natives from Uganda[5], Southern Sudan and Tanganyika[6] did not provide any specimens of hæmoglobin C. In South Africa, hæmoglobin C was found in 2 out of 219 blood specimens of Cape 'coloured' individuals[7]. However, as Lehmann points out, these sporadic cases may be the result of the introduction of slaves from West Africa.

As no results for hæmoglobin C are available for Central Africa, we undertook an investigation at Luluabourg, a town of 40,000 inhabitants, situated in the Kasai Province to the south of the Congo Basin. Blood specimens for paper electrophoresis of hæmoglobin were obtained from 500 unrelated and unselected natives. Most of them were young adults belonging to the important Baluba tribe. The apparatus and the technique used were those already described by one of us[8]. In addition to electrophoresis, all specimens were examined for sickling in 2 per cent sodium metabisulphite.

Of the 500 samples tested, 148 (29·6 per cent) showed sickling. In all these instances the electrophoretic pattern was that of the heterozygous sickling trait. All other hæmoglobin samples showed a single component corresponding to normal adult hæmoglobin. The pattern of homozygous sickle-cell anæmia was not encountered in our sample. Although sickle-cell anæmia is a very common disease at Luluabourg (75 new cases were seen during the past ten months) we were never able to diagnose the disease in adults beyond the second decade.

Apart from this investigation, 35 further specimens were selected from patients suffering from different symptoms suggestive of sickle-cell disease. The hæmoglobin of one of these patients showed the electrophoretic properties of a hæmoglobin S–C mixture, and was thus diagnostic for sickle-cell hæmoglobin C disease. This patient was a male adult with slight anæmia, numerous target cells and a high percentage of red cells sickling *in vivo*. His chief complaint arose from a mutilating necrosis of the femoral head. A complete case report of this patient has been published elsewhere[9].

The anthropological significance of this sporadic case has probably no more value than those found in the Cape 'coloured' population. The patient was originally from the enclave of Cabinda situated a few miles to the north of the Congo estuary. As there has been for generations a busy trade between the natives of Cabinda and those of the Guinea coast, the occasional presence of hæmoglobin C is not surprising. This study in association with other surveys provides further evidence that the diffusion area for the gene of hæmoglobin C does not extend south of the equator.

This investigation was supported in part by State of Washington Initiative 171 funds for research in biology and medicine.

J. Vandepitte
Medical Laboratory,
Luluabourg,
Belgian Congo.

Arno G. Motulsky
University of Washington
School of Medicine,
Department of Medicine,
Seattle, Washington.

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Orotic Acid as a Survival Factor in Rats Deficient in the Animal Protein Factors of Casein

Viviani *et al.*[1] have recently shown that orotic acid may be one of the growth factors for rats deficient in the animal protein factors of casein, but not for normal rats. These and previous[2,3] observations suggest a possible relationship between orotic acid and animal protein factors of casein. Therefore, in the present work, our investigations have been extended to the significance of prophylactic feeding of orotic acid upon the most dramatic aspect of the deficiency of animal protein factors of casein, namely, the high mortality of the newly born of the first generation and the total mortality of the second generation.

To this end, we have divided from weaning (21 days of age) thirty female rats of the Sprague–Dawley strain into three groups and placed them on the three experimental rations described in Table 1.

In these three groups of female rats and in the female rats of the subsequent filial generations, the survival of young from birth to weaning has been recorded. The results are reported in Table 2.

From the above results it appears evident that orotic acid may be a new factor for the survival of newly born rats deficient in the animal protein factors of casein.

Since orotic acid does not appear to be essential to survival, we think that orotic acid may be:

Table 1

Diets*	Basal	Devoid of casein animal prot. factors	Devoid of casein animal prot. factors + orotic acid
Ground cereals (wheat, maize, barley, oats, rye)	88	88	88
Crude rennet casein	5	—	—
Purified casein devoid of casein animal prot. factors (ref. 3)	—	5	5
Wheat germ	5	5	5
Calcium lactate	1·5	1·5	1·5
Sodium chloride	0·5	0·5	0·5
Orotic acid†	—	—	0·001

* The three diets are supplemented with carrots and fresh vegetables *ad libitum* twice a week.

† Orotic acid manufactured by Biochemical Inc., Co., Cleveland, Ohio

Table 2

Diets	Basal		Devoid of casein animal prot. factors		Devoid of casein animal prot. factors + orotic acid	
Generations	I	II	I	II	I	II
No. of animals	10	10	10	10	10	10
No. of young per litter	11	11	10·1	8·3	10·2	9·2
Mortality of young in 21 days (per cent)	2	2	72	100	6	7
Mean weight of young at 21 days (gm.)	48	48	32	—	46	43

(*a*) one of the animal protein factors; (*b*) a precursor or a part of the animal protein factors, should the animal protein factors prove to be unique substances; or (*c*) a substance with high sparing action on the animal protein factors of casein.

A. Rabbi
M. Marchetti
R. Viviani
G. Moruzzi

Istituto di Chimica Biologica,
Università di Bologna.
Dec. 14.

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The Striped Marlin (*Makaira audax* Phillipi) in South Africa

Marlin fishes of the genus *Makaira* Lacépède, 1803, occur throughout almost all tropical and temperate seas, and are of interest not only to the scientist but are also the prime quarry of the big-game angler. The systematics of these large wide-ranging fishes is troublesome, since few scientists can hope to examine an adequate series of fishes from over a wide area, and the number of species accepted by workers varies from three to the patently unacceptable sixteen of Jordan and Evermann (1926).

Makaira audax Phillipi, 1887, the well-known 'striped marlin', has hitherto been regarded as confined to the wide area of the Pacific. Although variable in colour and markings more or less according to where it occurs, and though these variations have been described as different species, the species is in effect sharply defined by the elevated front lobe of the dorsal fin, which is never less than, but almost always higher than, the depth of the body below, and about one and a third in the upper caudal lobe. The lateral line is virtually obsolete. The spear is slender, its width at tip of lower jaw about one-seventh of the preocular length of the mandible. The body is usually clearly striped.

By most American workers this species is regrettably labelled *M. mitsukurii* Jordan and Snyder, 1901, even though *audax* Phillipi clearly has priority.

This characteristic fish has been reliably recorded from the Western Pacific coast of America, Hawaii, Fiji, the seas about Japan, the Philippines, Australia and New Zealand. It has not before been certainly recorded from the Indian Ocean. Morrow[1] states that specimens of this species were seen alive in the sea off the coast of Kenya, but not captured. He also regards *Makaira brevirostris* (Playfair), 1866, as possibly this species; but from Playfair's description and the illustration[2], it is quite clear that Playfair's fish was a specimen of the widespread *indicus* Valenciennes, 1831.

LaMonte[3] records *Makaira mitsukurii* J. & S. (= *audax*) from Ceylon on the basis of a brief description and an illustration by Deraniyagala[4]. But it is quite plain that this Ceylon fish cannot be *audax*. In any event there is confusion, since in the first paper the fish figured is clearly only about 6 ft. in length, whereas the dimensions given in the "Atlas" show it as almost 12 ft.

The present account is based on a specimen captured by an angler off Mossel Bay, South Africa, at about lat. 34° 5′ S., long. 22° 12′ E. It was taken to Cape Town; but as there was doubt about its identity, on request of the Press I went by air to Cape Town to examine the fish, when I found that it was unquestionably *audax*. This is far south for any marlin to be captured, but is in line with their presence off New Zealand and the west coast of South America. It is noteworthy that specimens of the black marlin, *M. indicus* Valenciennes, have also been captured and many more have been seen at other parts along the shores of South Africa.

The main dimensions of this 160-lb. Mossel Bay specimen, in inches, are as follows: total length, 108; standard length, 89; snout tip, to eye, 21; to hind margin opercle, 34; to anal origin, 61½; depth of body, 13½; height of dorsal lobe, 18; of anal lobe, 11; upper caudal lobe, 24; lower, 23; tail spread, 34½; pectoral fin, 20¾; pelvic fin, 14¼; width of spear at tip lower jaw, $1\frac{3}{16}$, at two inches from apex, only $\frac{3}{8}$. The colour was brilliant purple, the numerous conspicuous transverse stripes faint lavender. The specimen is in my possession and will be mounted for retention in this Department.

Assistance from the South African Council for Scientific and Industrial Research has enabled this specimen to be preserved.

J. L. B. Smith*

Rhodes University,
Grahamstown,
South Africa.
Feb. 12.

* S.A. Council for Scientific and Industrial Research Fellow in Ichthyology.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 23

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "Electronics and Automation". Mr. G. W. A. Dummer: "Automatic Assembly Systems for Electronic Equipment" (with films and demonstrations).

Tuesday, April 24

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Berkeley Street, London, W.1), at 11 a.m.—Thirty-fourth Annual Corporate Meeting. 12 noon—President's Address—"The Technological Awakening".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting. Mr. A. W. Marsden: "Future Trends in Agricultural Production".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are Diesel Engines Inherently Noisy?"

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. R. H. Whitby: "The Development of Helicopter Transport".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Prof. H. Kramers: "Dynamic Characteristics of some Neutralization Processes and of Glass *p*H Electrodes".

Wednesday, April 25

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting. Dr. R. C. Sutcliffe: "The Moisture Balance of the Atmosphere" (Presidential Address).

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. M. Smith: "Radio and Television Interference—Its Growth and Effects".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. N. Grassie: "The Role of Abnormal Leakages in Polymer Degradation".

INSTITUTE OF METALS (at 4 Grosvenor Gardens, London, S.W.1), at 6.45 p.m.—Prof. Cyril S. Smith (University of Chicago): "The Beginnings of Metallography".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting—"Vital Statistics in Psychiatry". Chairman: Prof. Aubrey J. Lewis. Speakers: Dr. Vera Norris, Prof. L. S. Penrose, F.R.S., and Dr. Peter Sainsbury.

Thursday, April 26

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Meeting for election of Foreign Members. Mr. R. V. Coxon and Mr. R. J. Robinson: "Carbohydrate Metabolism in Blood Cells Studied by Means of Isotopic Carbon"; Mr. J. T. Davies, Mr. D. A. Haydon and Sir Eric Rideal, F.R.S.: "Surface Behaviour of *Bacterium coli*".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. C. M. Gray: "The Snowy Mountains Scheme".

CHADWICK TRUST (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Mr. J. Rawlinson: "The Centenary of London's Main Drainage System" (Chadwick Public Lecture).*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. A. C. B. Lovell, F.R.S.: Forty-seventh Kelvin Lecture on "Radio Astronomy".

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. A. Andreotti (University of Turin): "The Problem of Complete Intersections".* (Further Lecture on May 3.)

Friday, April 27

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF CIVIL ENGINEERS and the INSTITUTION OF ELECTRICAL ENGINEERS, at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Sir Maurice Bowra: "The Impact of Engineering on Society" (Graham Clark Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "Edmond Halley and His Work"

Saturday, April 28

BRITISH PSYCHOLOGICAL SOCIETY, SOCIAL PSYCHOLOGY SECTION (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 2.30 p.m.—Symposium on "Recent Developments in Survey Methods".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with research experience and preferably industrial experience) IN ORGANIC CHEMISTRY; and an ASSISTANT (Grade B) IN PHYSICS—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (April 25).

PHYSICIST (with an honours degree) IN THE DEPARTMENT OF PHYSICS APPLIED TO MEDICINE, for work concerned with the application of radioactive isotopes in clinical investigations—The Secretary, Physics Department, Middlesex Hospital Medical School, London, W.1 (April 25).

ANALYST (with a university honours degree or Associateship of the Royal Institute of Chemistry, and experience in a Public Analyst's or similar laboratory, preferably dealing with water and sewage analysis)—City Analyst, 126 Mount Pleasant, Liverpool 3 (April 28).

ASSISTANT LECTURER or LECTURER (with specialist knowledge in some aspect of microbiology or plant pathology) IN THE DEPARTMENT OF BOTANY—The Registrar, The University, Liverpool (April 28).

PRINCIPAL SCIENTIFIC OFFICER (with a degree of high standard in mathematics or equivalent qualifications, extensive experience of theoretical work in supersonic aerodynamics, and ability to direct the work of others) IN THE AERODYNAMICS DIVISION, Weapons Research Establishment, Salisbury, South Australia, to initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow, and to collaborate with staff carrying out experimental work in this field, and to exercise supervision over the work of other scientific staff—The Senior Representative (A.P.42/1), Department of Supply, Australia House, Strand, London, W.C.2 (April 30).

ENGLISH ELECTRIC RESEARCH FELLOW IN AERONAUTICS for postgraduate research into problems of vibration or stability and control of aircraft—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

ASSISTANT ADVISORY BACTERIOLOGIST (with an honours degree in bacteriology or equivalent, and postgraduate experience) at Perth Sub-Station—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (May 4).

ASSISTANT EXPERIMENTAL OFFICER (with a degree in botany or an allied biological science) IN THE DEPARTMENT OF PLANT BREEDING, to assist with cytological studies of horticultural crops—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (May 5).

ASSISTANT LECTURER or LECTURER (preferably on the experimental side) IN PHYSICS—The Registrar, The University, Sheffield (May 5).

MATHEMATICIANS, Experimental Officer or Assistant Experimental Officer grade (preferably with a pass degree in mathematics, or at least H.S.C. (science) or equivalent) at the Ministry of Supply Ordnance Board, London, for work on ballistics (duties include analysis of experimental results and computation of gunnery data)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.126/6A (May 5).

ASSISTANT LECTURER (with a good honours degree and some research experience) IN PHYSICAL CHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (May 11).

LECTURER or ASSISTANT LECTURER IN PHYSIOLOGY—The Registrar, The University, Sheffield (May 12).

SOIL MINERALOGIST (with a university honours degree in science, with chemistry and geology as major subjects, and preferably soil research experience) IN THE DIVISION OF SOILS, Commonwealth Scientific and Industrial Research Organization, South Australia, to conduct research into the mineralogy of soils, as part of a programme relating to chemical properties with mineral composition—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 270/123 (May 12).

LECTURER IN ANTHROPOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, May 14).

SCIENTIFIC OFFICER (with a science degree of a university in the U.K., with passes in biochemistry, zoology or botany, etc., and preferably relevant postgraduate experience) at the Blood Transfusion Centre, Oxford—The Medical Director, Regional Blood Transfusion Centre, Churchill Hospital, Headington, Oxford (May 14).

SCIENTIFIC OFFICERS (2) (with an honours degree in animal husbandry or equivalent qualification) for experimental work with hill sheep and cattle; and SCIENTIFIC OFFICERS (2) (with an honours degree in botany, agricultural botany or principles of plant husbandry) IN THE BOTANY DEPARTMENT—The Secretary, Hill Farming Research Organization, 48 Palmerston Place, Edinburgh 12 (May 14).

PLANT PHYSIOLOGIST (with an honours degree in science or agricultural science and postgraduate research experience in plant physiology) IN THE DEPARTMENT OF PLANT PHYSIOLOGY, Waite Agricultural Research Institute, for research in the general field of carbohydrate metabolism of economic plants—The Registrar, University of Adelaide, Adelaide, South Australia (May 15).

DR. LEE'S PROFESSOR OF EXPERIMENTAL PHILOSOPHY—The Registrar, University Registry, Oxford (May 17).

ASSISTANT IN THE DEPARTMENT OF GEOGRAPHY; and a LECTURER (with special knowledge in the geography of climate, soil and vegetation) IN THE DEPARTMENT OF GEOGRAPHY—The Assistant Secretary, The University, Edinburgh (May 19).

ASSISTANT LECTURER (preferably with special qualifications and experience in animal husbandry) IN ANIMAL HUSBANDRY, at the School of Agriculture, Sutton Bonington, near Loughborough—The Registrar, The University, Nottingham (May 19).

LECTURER IN MATHEMATICS—The Secretary, The University, Aberdeen (May 19).

LECTURER (with special qualifications in applied mathematics, and preferably an interest in fluid dynamics) IN MATHEMATICS—The Registrar, The University, Manchester 13 (May 19).

ASSISTANT LECTURER IN PHYSICS—Prof. K. G. Emeleus, Queen's University, Belfast (May 20).

ASSISTANT LIBRARIAN (preferably science graduate with professional diplomas and experience), at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 21).

LECTURER (with training and research experience) IN MATHEMATICAL PHYSICS—The Registrar, The University, Birmingham (May 22).

HENRY BELL WORTLEY CHAIR OF METALLURGY—The Registrar, The University, Liverpool (May 26).

LECTURER (with training and experience in experimental physics) IN PHYSICS, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (May 31).

SENIOR LECTURER (with a degree in science or engineering, with geology as a major subject, and field experience in mining and/or engineering geology, and preferably experience in mineragraphy and/or geophysical exploration) IN ECONOMIC GEOLOGY, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, June 1).

BIOCHEMIST (Senior grade) to the Rochdale Group of Hospitals—The Group Pathologist, Birch Hill Hospital, Rochdale, Lancs.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with a good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

ENGINEERS and PHYSICISTS (particularly with electronics) (Experimental Officer and Assistant Experimental Officer grades), in Experimental Establishments, in the London, Portsmouth and Weymouth areas, Cheltenham and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.214/5A.

LECTURER (preferably with an honours degree, and teaching, research or industrial experience) IN PHYSICS; and an ASSISTANT LECTURER, Grade B (preferably with an honours degree, and teaching, research or industrial experience) IN PHYSICS—The Clerk to the Governors, Mid-Essex Technical College and School of Art, Market Road, Chelmsford.

LECTURER (specializing in palæontology-stratigraphy) IN GEOLOGY, and a LECTURER (specializing in petrology-mineralogy) IN GEOLOGY—The Acting Dean, College of Arts and Science, Baghdad, Iraq.

LECTURER (with a degree or equivalent in microbiology or bacteriology, and preferably some experience of industrial applications) IN MICROBIOLOGY—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

READER or SENIOR LECTURER IN MECHANICAL ENGINEERING; a SENIOR LECTURER, LECTURER or ASSISTANT LECTURER IN MECHANICAL ENGINEERING; and a SENIOR LECTURER, LECTURER or ASSISTANT LECTURER IN CIVIL ENGINEERING, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

SENIOR LECTURER IN PHYSICS—The Secretary, Royal Technical College, Glasgow.

SENIOR LECTURER IN PHYSICS to teach up to B.Sc. (Special) Degree standard—Northern Polytechnic, Holloway, London, N.7.

SOIL SURVEYORS (with B.Sc.(Agr.) or equivalent qualification) with the New South Wales Department of Agriculture, to carry out soil surveys in any part of New South Wales, prepare data and draft maps from surveys, laboratory work, etc.—The Agent General for New South Wales, 56 Strand, London, W.C.2.

TECHNICAL OFFICER (with a degree in botany or equivalent qualifications, and preferably practical experience of seed production) for herbage seed multiplication—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

TECHNICAL RESEARCH ASSISTANT IN THE BACTERIOLOGY DEPARTMENT—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Association of Scientific Workers. Atomic Energy Progress Notes Vol. 1: Pp. ii+45. Third edition. 2*s.* 6*d.* Vol. 2: Pp. ii+32. Third edition. 2*s.* 6*d.* Vol. 3: Pp. ii+24. 2*s.* 6*d.* (London: Association of Scientific Workers, 1955 and 1956.) [72

National Institute of Agricultural Botany. Farmers' Leaflets. No. 2: Varieties of Spring Wheats and Spring Barleys. Pp. 4. No. 8: Varieties of Winter Wheats. Pp. 4. No. 9: Varieties of Winter Oats and Winter Barleys. Pp. 2. No. 12: Rye. Pp. 2. No. 13: Varieties of Spring Oats. Pp. 4. (Cambridge: National Institute of Agricultural Botany, 1956.) [72

British Museum (Natural History). Great Barrier Reef Expedition 1928–29. Scientific Reports. Vol. 6, No. 5: The Sergestidae of the Great Barrier Reef Expedition. By Dr. Isabella Gordon. Pp. 323–334. (London: British Museum (Natural History), 1956.) 5*s.* [72

Instructions for Rearing and Breeding Locusts in the Laboratory. By P. Hunter-Jones. Pp. 9. (London: Anti-Locust Research Centre, 1956.) [72

Brightray Coated Exhaust Valves. Pp. 8. Wiggin Nickel Alloys by Powder Metallurgy. Pp. 20. (Birmingham: Henry Wiggin and Co., Ltd., 1956.) [72

Mechanisms: an International Bibliography. Compiled and Edited by Dr. P. Grodzinski. Vol. 1, No. 1 (January 1956). Pp. 8. Basic annual subscription in the United Kingdom, 21*s.*; abroad 25*s.* (London: Dr. Paul Grodzinski, 41 Tudor Close, N.W.3.) [72

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1, No. 1: The Structure of the Skin and Dermal Scales in the Tail of *Acipenser ruthenus* L. By Ian C. Smith. Pp. 1–14+3 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 5*s.* 9*d.* [72

National Union of Students. 1955/6 Survey of Local Education Authority Awards to Students and Grants Year Book. Pp. 84. (London: National Union of Students, 1956.) 1*s.* [92

University of Leeds. Publications and Titles of Theses 1952–3. Pp. 76. (Leeds: The University, 1955.) 6*d.* [92

Field Studies Council. Annual Report 1954–1955. Pp. 64+8 plates. (London: Field Studies Council (A. G. T. Oakley, Secretary and Treasurer, 119–125 Finsbury Pavement), 1956.) [142

Mental Health Research Fund. Annual Report and Balance Sheet as at 30th September, 1955, with Income and Expenditure Account for the year to that date. Pp. 12. (London: Mental Health Research Fund, 1956.) [142

Report of the Committee of Inquiry into the Electricity Supply Industry. Pp. viii+189. (Cmd. 9672.) (London: H.M. Stationery Office, 1956.) 6*s.* 6*d.* net. [152

New Developments in Industrial Leadership in Great Britain, the United States, Germany and France. Edited by Frank A. Heller. (New Development Series, No. 1.) Pp. 75. (London: Polytechnic Management Association, 1955.) 5*s.* [152

Iodine Information No. 45: Analytical Chemistry, Iodine Methods 1953/1955. Pp. 56. (London: Chilean Iodine Information Bureau, 1956.) [152

Other Countries

Tea Research Institute of East Africa. Annual Report for the year 1954. Pp. 42. Pamphlet No. 12: Proceedings of the Third Conference, 12th August, 1955. Pp. 48. (Kericho: Tea Research Institute of East Africa, 1955.) [32

Biologische Bundesanstalt für Land- und Forstwirtschaft in Berlin-Dahlem. Bibliographie der Pflanzenschutzliteratur, 1951. Bearbeitet von Regierungsrat Dr. J. Bärner. Pp. xliv+420. (Berlin: Verlag Paul Parey, 1955.) [32

Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 36, No. 12: Large Population Increase in 1955. Pp. 12. (New York: Metropolitan Life Insurance Company, 1955.) [72

Radio-Philatelia. By Herbert Rosen. Pp. 48. (New York: Audio-Master Corporation, 1956.) 2 dollars. [72

Conseil Permanent International pour l'Exploration de la Mer, Charlottenlund Slot, Danemark. Annales Biologiques, Vol. 11, 1954. Rédigé par A. Fridriksson. Pp. 186. 40 kronor. Rapports et Procés verbaux des Réunions. Vol. 140, Part 2: Herring Tagging Techniques and Results. Pp. 54. 15 kronor. (Copenhague: Andr. Fred. Høst et Fils, 1955 and 1956.) [72

Durban Museum and Art Gallery. Annual Report for the Municipal Year 1954–1955. Pp. 16. (Durban: Durban Museum and Art Gallery, 1955.) [72

Harvard University: Blue Hill Meteorological Observatory. Meteorological Radar Studies. No. 2: Spiral Precipitation Patterns in Extratropical Cyclones. By John H. Conover. Pp. iii+11+9 figures. No. 3: The Melting Layer. By Raymond Wexler. Pp. iv+18. (Milton, Mass.: Blue Hill Meteorological Observatory, 1955.) [72

Proceedings of the Ninth Annual Conference on the Administration of Research, September 7–9, 1955, North-western University Technological Institute, Evanston, Illinois, U.S.A. (University Series.) Pp. 107. (New York: New York University Press, 1956.) 4 dollars. [72

Commonwealth Scientific and Industrial Research Organization, Australia. Soil Publication No. 5: Mineralogical Examination of a Yellow Podzolic Soil Formed on Granodiorite. By R. Brewer. Pp. 28+1 plate. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1955.) [72

Institut de France. Académie des Sciences Annuaire pour 1956. Pp. 1+225. (Paris: Gauthier-Villars, 1956.) [92

Trinidad and Tobago. Forest Department Annual Report for the year 1954. Pp. 44+1 map. (Trinidad: Government Printing Office, 1955.) 36 cents. [92

Quarterly Bulletin of the International Association of Agricultural Librarians and Documentalists. Vol. 1, No. 1 (January 1956). Pp. 35. Subscription rates: Libraries and other Institutions: 50 Swiss francs; 45 Dutch florins; 82*s.* 6*d.*; 12.50 dollars. Individual subscription for personal and private use only: 10 Swiss francs; 8 Dutch florins; 16*s.* 6*d.*; 2.50 dollars. (Wageningen, Netherlands: Mr. T. P. Loosjes (Treasurer), Centrum voor Landbouwdocumentatie, General-Foulkes Weg. 1A., 1956.) [152

Das Erdbeben von Basel. Von Andreas Staehelin. Die Erdbebentätigkeit in Basel und Umgebung seit dem grossen Erdbeben. Von Max Bider. (Sonderabdruck aus dem Basler Jahrbuch, 1956.) Pp. 11–44. (Basle: Basler Jahrbuch, 1956.) [152

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